IRON AND STEEL ENGINEER

J. F. KELLY, Editor

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Tech 50

COMING MEETINGS AND PAPERS

PITTSBURGH SECTION

TOPICAL DISCUSSION

"MANIPULATORS FOR REVERSING BLOOMING MILLS"

By

Mesta Machine Company,
United Engineering & Foundry Company,
Mackintosh Hemphill Company.

2:30 P. M., Saturday, February 27th, 1926

Blue Room, Wm. Penn Hotel, Pittsburgh, Pa.

SAFETY CONGRESS

"THE SAFE OPERATION OF ELECTRIC OVERHEAD TRAVELING CRANES"

The meeting begins at 10:00 A. M., Wednesday, March 10th.
(Program appears on page III of this issue)

APRIL, 1926

"MAINTENANCE — STEAM TURBINES"

By A. L. Penniman, Jr., Supt. Steam Stations, Consolidated Gas, Electric Light and Power Company, Baltimore, Md.

PHILADELPHIA SECTION

SATURDAY, MARCH 6th, 1926

"MAGNETIC CONTROL FOR STEEL MILL AUXILIARIES"

By H. H. Angel, General Foreman and Control Specialist, Bethlehem Steel Company, Sparrows Point, Md.

SATURDAY, APRIL 10th, 1926

"GENERAL IDEAS AND DISCUSSION"

Every active member is invited to prepare a short paper on a subject pertaining to the application of Electricity to the Iron and Steel Industry.

MAY, 1926

INSPECTION TRIP.—The Bethlehem Steel Company invites the members of the Association to visit the Maryland Plant of the Bethlehem Steel Company, located at Sparrows Point, Md. Details will be announced later.

All meetings of the Philadelphia Section are held in the Engineers Club, 1317 Spruce Street, and will start promptly at 7:30 P. M. They are preceded by an informal dinner at 6:00 P. M.

CLEVELAND SECTION

FRIDAY, FEBRUARY 26th, 1926

"GET-TOGETHER MEETING"—Reception and Dance

Hotel Winton, Cleveland, Ohio.

Members and immediate friends invited.

CHICAGO SECTION

THURSDAY, MARCH 10th, 1926

"FREQUENCY CONVERTERS FOR INTERCHANGE OF POWER BETWEEN STEEL MILLS AND CENTRAL STATIONS"

By F. J. Schwarz, Industrial Engineer, General Electric Company, Schenectady, New York.

Dinner 6:30 P. M.
Meeting 8:00 P. M.

Electric Club Rooms, 30 No. Dearborn St.,

SAFETY CONGRESS

Auspices

SAFETY DIVISION

Association of Iron & Steel Electrical Engineers

WEDNESDAY, MARCH 10th, 1926

Blue Room—Wm. Penn Hotel **Pittsburgh, Pennsylvania**

SUBJECT:

"THE SAFE OPERATION OF ELECTRIC OVERHEAD TRAVELING CRANES"

WEDNESDAY MORNING, 10:00 O'CLOCK

EMPLOYING AND TRAINING CRANE OPERATORS—

A—Safe Crane Operators.
Physical and Mental Requirements, Tests, etc.
B—Teaching Men to Operate Cranes.
Operators to Be Selected From.
1st—Floating Labor or Gang.
2nd—Experienced Operators.
3rd—Course of Training.

WEDNESDAY AFTERNOON, 2:00 O'CLOCK

CRANES—

A—Ladders, Steps, Walks, Platforms.
B—Guards, Falling Crane Parts, Failure of Ropes.
C—Switches, Location of Switches, Manual or Magnetic Control, Hoist Limit Switches, Exposed Current Carrying Parts.
D—Inspection.
E—Lubrication.
F—Fire Hazards.

RUNWAYS—

A—Signals.
B—Rules for Workmen and Repairmen on Runways.
C—Approaches to Runways.
D—Rail Stops.
E—Sanders.

EDUCATIONAL—

A—Crane Operators Rules.
B—Crane Directors Rules.

COMMITTEE ON GENERAL ARRANGEMENTS

C. L. Baker, General Chairman; Managements Representative, Bethlehem Steel Company, Johnstown, Pa.

R. G. Adair, Vice Chairman; Safety Director, American Rolling Mills Co., Middletown, Ohio.

J. A. Oartel, Safety Director, Carnegie Steel Company, Pittsburgh, Pa.

J. C. Reed, Electrical Engineer, Bethlehem Steel Company, Steelton, Pa.

A. C. Germain, Safety Director, Minnesota Steel Company, Duluth, Minnesota.

A. C. Gibson, Safety Director, Spang-Chalfant Company, Etna, Pa.

W. S. Hall, Electrical Engineer, Illinois Steel Company, So. Chicago, Ill.

Walter Greenwood, Safety Director, Carnegie Steel Company, Youngstown, Ohio.

CRANE BUILDERS COMMITTEE

Morgan Engineering Company, Alliance, Ohio.

Harnischfeger Corp., Milwaukee, Wis.

Niles, Bement, Pond Company, Philadelphia, Pa.

Cleveland Crane & Engineering Company, Wickliffe, Ohio.

Chesapeak Iron Works, Baltimore, Md.

Alliance Machine Company, Alliance, Ohio.

Shepard Elec. Crane & Hoist Co., Montour Falls, N. Y.

Milwaukee Crane Company, Milwaukee, Wis.

Whiting Corporation, Whiting, Ind.

Euclid Crane & Hoist Co., Euclid, Ohio.

Shaw Crane Works, Muskegon, Mich.

Northern Engineering Works, Detroit, Mich.

Toledo Crane Company, Bucyrus, Ohio.

Alfred Box & Co., Philadelphia, Pa.

APPLICATION FOR MEMBERSHIP

Iron and Steel Industry's Combustion Engineering Division

ASSOCIATED WITH

Association of Iron & Steel Electrical Engineers

PURPOSE

The Combustion Engineering Division of the A. I. & S. E. E. is composed of engineers whose problems have to do with the economical uses of Fuel in the processing and production of Iron and Steel.

ACTIVITIES

The activities of the Combustion Engineering Division are confined exclusively to the Iron and Steel Industry. The main object is the improving of all fuel consuming equipment, both primary and auxiliary, i. e., coke ovens, blast furnaces, open hearth furnaces, gas producers, heating furnaces, steam boilers, steam engines and gas engines.

MEMBERSHIP

Every member is entitled to the proceedings and transactions of the Cleveland, Pittsburgh, Birmingham, Philadelphia and Chicago sections of the A. I. & S. E. E. The proceedings of the Fuel Savings Conference, the use of the National Headquarters clearing house for data, attendance at the Annual Conventions, and Iron and Steel Expositions, the Monthly issue of the Iron and Steel Engineer (the Steel Industrys' recognized engineering periodical) the Yearly transactions of the A. I. & S. E. E., the privileges of all inspection trips to Iron and Steel Plants.

Date.....

To the Combustion Engineering Division:

Application is hereby made for admission to the Combustion Engineering Division of the A. I. & S. E. E. Upon notification of such admission I promise to pay the entrance fee of $10.00, and dues of $10.00, $5.00 thereof being in payment of a year's subscription to the Iron and Steel Engineer, the official organ of the Combustion Engineering Division.

Name.....

Residence ..... St. ..... City ..... State

State present position.....

Company .....

City ..... State .....

Return this application to any one of the following:

W. P. Chandler, Spec. Engr., Carnegie Steel Company, Pittsburgh, Pa.
Walter Flanagan, Steam Engr., Carnegie Steel Co., Youngstown, Ohio.
H. C. Siebert, Comb. Engineer, Bethlehem Steel, Co., Bethlehem, Pa.
Mr. G. R. McDermott, Asst. Chief Engr., Illinois Steel Co., So. Chicago, Ill.
Mr. F. G. Cutler, Chief Bureau of Steam Eng., Tennessee Coal, Iron and Railroad Co., Ensley, Ala.
Mr. A. G. Witting, Asst. Chief Engr., Illnois Steel. Co., Gary, Ind.
E. W. Trexler, Comb. & Steam Engr., Bethlehem Steel Co., Johnstown, Pa.
W. J. Harper, Steam Engr., Donner Steel Co., Buffalo, N. Y.
Mr. C. H. Hunt, Chief Engr., Weirton Steel Co., Weirton, W. Va.
Mr. J. C. Allen, Chief Engr., Carnegie Steel Company, New Castle, Pa.
Mr. A. Steed, Supt. Power Div., American Rolling Mill Co., Middletown, Ohio.

22nd ANNUAL CONVENTION

—AND—

IRON AND STEEL EXPOSITION

June 7th, 8th, 9th and 10th, 1926

Hotel Sherman **Chicago, Ill.**

"Everything Under One Roof"

TENTATIVE TECHNICAL PROGRAM

MONDAY, JUNE 7th, 1926

"SAFETY CONGRESS"

A. I. & S. E. E. Recommendations "Rules for the Safe Operation of Electric Overhead Traveling Cranes."

TUESDAY, JUNE 8th, 1926

"Standardization of Mill Type Motors."

"Tests in connection with Uniflow Engine, built by Nordberg Engine Company."

WEDNESDAY, JUNE 9th, 1926

"Refractories for the Iron and Steel Industry."

"Report of Electric Heat Committee."

THURSDAY, JUNE 10th, 1926

"Electric Transportation Yards, Mills, Shops and Factories."

FRIDAY, JUNE 11th, 1926

"Inspection Trip."

IRON AND STEEL EXPOSITION

TO THE EXECUTIVES,
IRON AND STEEL INDUSTRY,
UNITED STATES AND CANADA.

Gentlemen:

The Association of Iron and Steel Engineers, this year, is instituting a program which is intended to keep the Steel Industry, as a whole, informed of all developments of electrical heating which would be of interest to the various members.

The information, which it is the Association's desire to disseminate to the industry through a report published each year, should contain the salient reasons for continuing in service the various electric heat installations which have been made, and also the possible sources of economy which might be expected through new installations.

In order that the Association's work may be of direct value to you, we ask that you examine the outline of this year's report and let us know if there are any other phases to this subject which you would care to have us include in our program.

The main value of the report will be the statements of users of various equipment as to its advantages or disadvantages and we trust that when your co-operation is requested, from time to time, that you will find it possible to give us the assistance desired.

Trusting that when the annual report of Electrical Heat Committee is issued by the Association you will find it of lasting value, I am,

Yours very truly,

W. P. CHANDLER,
Chairman Electrical Heat Committee.

Outline of Report

ELECTRIC HEAT COMMITTEE

To Be Presented At

TWENTY-SECOND ANNUAL CONVENTION

—OF—

Association of Iron and Steel Electrical Engineers

JUNE 7th, 8th, 9th and 10th, 1926

Hotel Sherman, Chicago, Ill.

—o—

ARC MELTING FURNACES—

a—Developments 1926.
By Manufacturers and Builders.
b—Reports by Arc Melting Furnace Operators.

INDUCTION MELTING FURNACES—

a—Developments.
By Manufacturers and Builders.
b—Reports by Induction Melting Furnace Operators.

RESISTANCE FURNACES (High Temperature Applications)

A—Soaking Pits.
B—Carbonizing and Hardening.
C—Annealing.
a—Wire Mills.
b—Sheet Mills.
c—Cold Rolled Strip Mills.
d—Special Grade Steels.
D—Heat Treating Furnaces.
a—Tool Rooms.
E—Electric Hot Top for Moulds.
a—Steel Ingots.
b—Roll Manufacturers.

ROLL HEATERS—

a—Developments 1926.
Reports by Manufacturers.
b—Sheet Mill Operators.

LOW TEMPERATURE APPLICATIONS—

A—Galvanizing.
a—Developments 1926.
By Manufacturers and Builders.
b—Report by Operators.
B—Tin Pots.
a—Developments 1926
By Manufacturers and Builders.
b—Report by Operators.
C—Wire Drying.
a—Developments 1926.
By Manufacturers and Builders.
b—Report by Operators.
D—Core Ovens.
a—Developments 1926.
By Manufacturers and Builders.
b—Reports by Foundry Industry.

WELDING—

A—Spot.
a—Wire Fence Industry.
B—Arc Welding.
a—By Steel Industry.

EDITORIALS

To the Members of the Association of Iron and Steel Electrical Engineers:

Many of you have heard rumors of a new mill type motor which is shortly to appear on the market. It has been reported that the new motor will differ somewhat in design from the mill type motors with which we all are familiar. For this reason, the officers of the Association call the attention of the active members to "Association's" effort to secure uniform external dimensions for these new motors, regardless of by which manufacturer they are produced. This project is progressing rapidly, and with promise of success. The following has been accomplished:

(1) Letters have been written to the presidents of the steel companies, asking for their approval of this campaign. Although these letters were sent out only three weeks ago, we already have favorable replies from many companies, including most of the large steel producers.

(2) Informal discussions with the representatives of two of the manufacturers of mill type motors with the idea of determining what new features would be incorporated in the revision of mill type motor design.

(3) Letters were mailed January 21 to the presidents of the large electrical manufacturing concerns requesting that they co-operate with the Association in attempting to standardize external dimensions and secure uniform ratings and speeds. At this writing we have a reply from one of the manufacturers which states that he believes this project can be successfully consummated.

In order that there may be no misunderstanding, we list the specific features to be standardized:

(1) HP ratings and speeds
(2) External dimensions.
(3) Shaft diameters, tapers, keys, keyways and shaft tolerances.
(4) Mounting bolt hole dimensions.
(5) Bearings (anti-friction only and—in size only.)

In other words, enable users of mill type motors to refer to the same outline dimension sheets regardless of by whom the motors are produced.

One of the active members of the Association estimated that had this been done at the time the present mill type motors were first developed, electrical inventories would be at least 30% less at the present time. We feel that this project deserves the support of every active member of the Association.

We have the support of the steel manufacturers and the electrical manufacturers will undoubtedly do all in their power to go along with us.

In order to expedite the work of Standards Committee, it is essential that we secure the opinions of the membership in regard to the features on the attached questionnaire.

It will be necessary to have the replies to these questions in the hands of the Committee not later than February 23. We ask your co-operation and hope we may be able to give you service in this matter.

Yours very truly,

A. C. CUMMINS, Past President,

Chairman Standardization Committee.

QUESTIONNAIRE: STANDARDIZED MILL TYPE MOTOR

(1) Will steel mill electrical engineers be satisfied with box type non-split frame mill type motors, even if they can be purchased for 20% less money, are lighter, and occupy less space?

(2) Do steel mill electrical engineers desire mill type motors designed to accommodate anti-friction bearings only rather than motors designed to permit the installation of either anti-friction or sleeve bearings?

(3) If motors are designed with frames which will accommodate either sleeve or anti-friction bearings, must the arrangement of bearings be such as to permit the use of either type in the same frame interchangeably?

(4) Shall the new mill type motor have bearings provided with sufficient end thrust capacity to permit the use of single spiral seven to ten degree helical gearing?

(5) Can the number of ratings be reduced? If you believe it can, submit a list of one-hour ratings, which will meet your requirements up to 225 HP.

(6) Do you believe increased speeds for mill type motors is desirable?

(7) Do you desire motors having armatures built on a spider and commutators mounted on an extension thereof?

(8) The committee will be grateful for any other suggestions that you may have covering features which would be desirable to have included in improved designs of mill type motors. Such suggestions should be made with the idea of solving general maintenance problems rather than specific cases.

SAFETY CONGRESS

The Steel Industry was the first industrial to recognize the greatest humanitarian movement in existence today, "The Protection of Human Life," and instituted organized safety in its plants as early as 1905. The A.I.&S.E.E., from the day of its inception, in 1907, treated the Safety Problem in such a manner that it attracted natoin-wide attention.

In 1908, Mr. J. C. Reed, then President of the A.I.&S.E.E., selected and appointed the first Safety Committeee, whose efforts were directed, in a national way, to the protection of human lives.

(Continued on Page 123)

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Electrically Heated Hot Top Ingots

By F. C. WATSON*

FOR many years Monel and Nickel ingots have been cast with a head averaging 18" long and weighing approximately 800 lbs., the purpose of the long head being to take care of gas holes and pipes. Of course, it was always necessary to saw off the head and return it to the furnace for remelting.

The desire to produce an ingot, which would be solid throughout its length and with as little excess metal as possible, has brought about the development of certain apparatus and methods which are to be described in this paper. It should be understood that all of the experiments and practical results obtained have been with Monel and Nickel ingots. There has not been any opportunity to try the methods on ferrous metals.

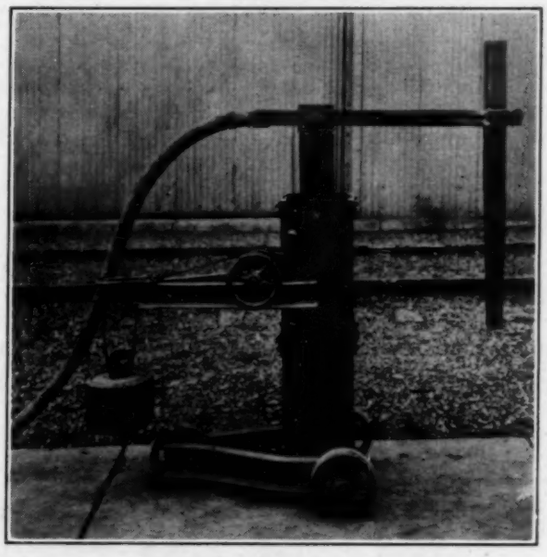

FIG. 1.

Early in the year 1924 plans were made to develop and study methods to dispense with the large ingot heads. Naturally, the first thing that suggested itself was the use of an electric arc to keep the metal at the top of the ingot hot while the bottom and sides were cooling. The hot metal at the top would be available to fill up any holes caused by shrinkage.

A single electrode carried on a portable truck was built for experiments. This equipment is shown in Fig. 1.

Means were provided for moving the electrode up and down manually. An old single phase transformer being available, several trials were made in which one conductor was attached to the side of the mold and the other attached to the electrode. The results of these tests were somewhat encouraging, but in order to try out the apparatus on a number of voltages, it was connected to one of the electric furnace transformers giving voltages as low as 59 volts.

*Elec. Supt., International Nickel Company, Huntington, W. Va.

From these early experiments enough information was obtained to prove that a solid ingot could be made, but to put the system on a practical and economical basis it would be necessary to have automatic control of the electrode, a more practical

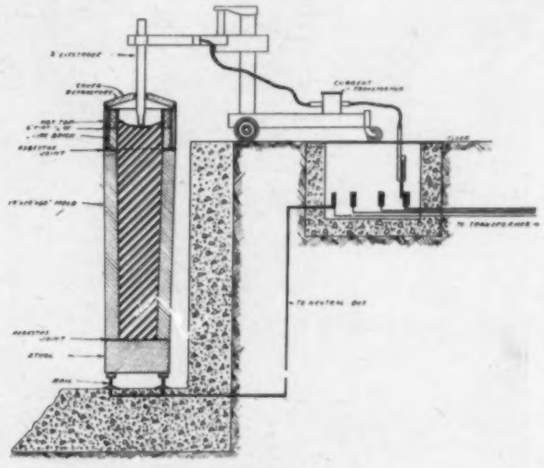

FIG. 2.

method of connecting to the mold, a quick and safe method of connecting the electrode to the source of power from which a large current would be taken. The equipment would have to be nearly fool proof, substantial and easy to operate.

FIG. 3.

A brief description of the methods used in the casting of ingots will make it clearer as to why certain plans were adopted. All ingots are poured with the mold in a pit, the top of the mold being about on a level with the main floor. All ingots are poured with the large end up. The metal is poured at an average temperature of 2,750.

Fig. 2 illustrates in a simplified manner, the scheme which was originally adopted and developed to produce a solid ingot by the electrically heated hot-top method.

In Figs. 3, 4, 5, is pictured one of the trucks carrying an automatically controlled electrode. The truck was built and all parts assembled in the company's shop. The electrode arm is raised and lowered by a small winch connected to a ¼ H.P. 230 Volt D.C. motor through a small worm drive. The

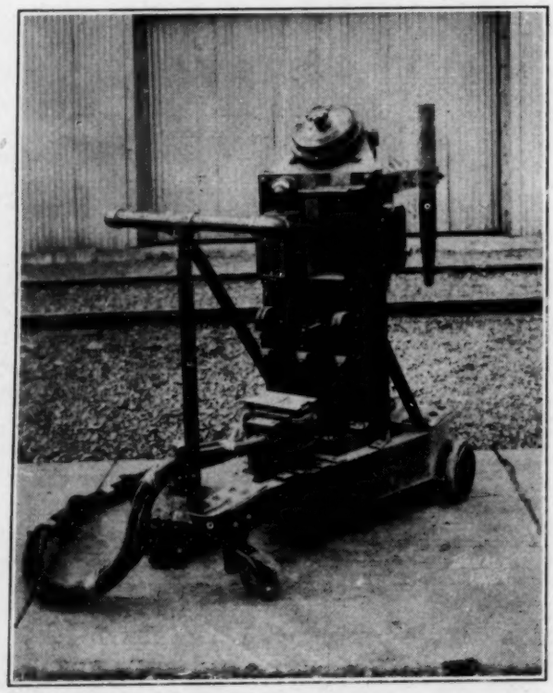

FIG. 4.

winch, motor and worm drive are mounted in the base of the truck. The motor is controlled through a furnace type control panel, made up of the following apparatus:

1—Contact Making Ammeter
1—Regulating Rheostat
1—Undervoltage Relay.
1—Current Transformer, Ratio 2000 to 5
1—Push Button Starter.
1—S.P. "Raising" Contactor with Dynamic Braking Contact
1—S.P. "Lowering" Contactor with Dynamic Braking Contact
1—S.P. Slow-Down Contactor

The contact making ammeter with its adjusting rheostat provides a means of regulating the amount of current that the operator wishes to use through the electrode. This can be varied from 200 to 4,000 amperes.

The undervoltage relay has its holding coil connected across the arc circuit so that in case the A.C. power fails the relay coil releases and holds open the "lowering' contactor, thus preventing the electrode from being lowered into the bath. When the A.C. power comes on again the relay is closed, allowing the "lowering" contactor to become operative and the arc is re-established automatically.

The type of push button station used permits of hand or automatic raising and lowering of the electrode.

The electrode clamp does not require water cooling, and is therefore made from standard copper bus ¼" x 4". The casting on the column carrying the electrode arm has been provided with sufficient counter balance so that it will ride up and down the column freely, the column being provided with two vertical guides.

The truck is provided with rubber tires for two reasons—one, to prevent accidental grounding and more especially to take up the shocks due to rolling over the floor. As only five trucks are available, it is necessary to transfer them to any point around the pit. One man can easily handle a truck. The truck is provided with a flexible conductor made up of 3 single conductors of 300,000 cm each. Dynamo cable is used on account of its flexibility The electrode arm is connected to the main conductor by several strands of flat brush shunt cable covered by a layer of asbestos tape. As a means for connecting the main conductor to the source of power, a plug was designed and it is made up of two pieces of ¼" x 4" bus copper mounted on a wooden handle. In addition to the two ¼" x 4" contacts there are three finger contacts for making the 230 volt D.C. circuit and the A.C. circuit for the undervoltage relay. In building up the truck with its appurtenances the aim of simplicity was always kept in mind.

There is another feature which has been given consideration and might be used to advantage. This is a definite time relay. To use this relay an independent 110 volt A.C. circuit would have to be supplied. A relay of this type would add to the equipment an automatic timing feature having a range of

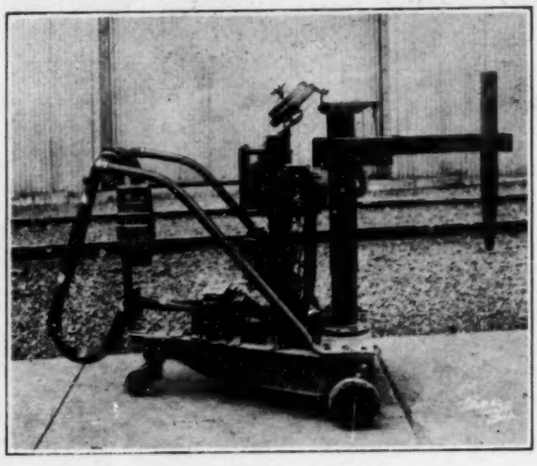

FIG. 5.

2 seconds to 30 minutes. It could be so connected that at the end of the predetermined time the electrode would be raised and the arc broken.

After nine months' experience with the trucks it has not been found necessary to use any limit switches.

POWER TRANSFORMER

The A.C. power for heating the ingot top is supplied from an 1800 KVA 3 phase, 60 cycle furnace type transformer designed for 2200 volt primary

voltage. This particular transformer was purchased as a spare or duplicate of the other furnace transformers in the plant. Knowing that considerable experimenting with secondary voltages would be desired, additional secondary voltage taps were brought out. At this time the transformer is being used with a delta primary connection and a Y secondary connection giving approximately 100 volts

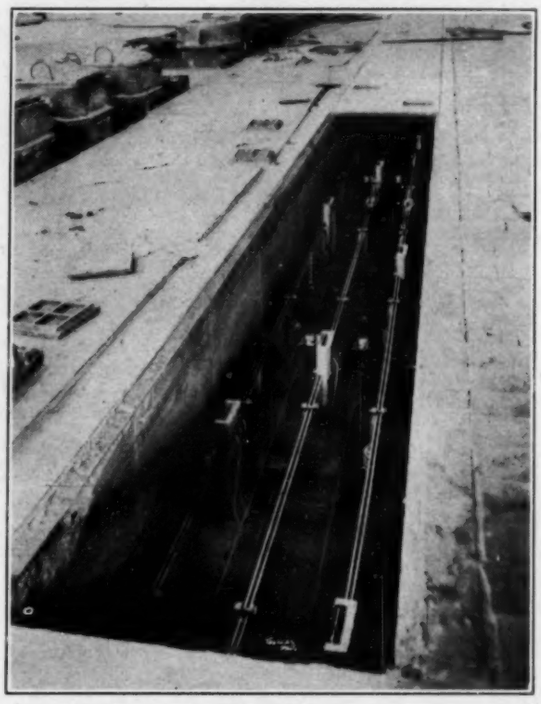

FIG. 6.

from phase to neutral. As shown in Fig. 2 the neutral is connected to the rails supporting the molds.

The transformer is provided with an air core type reactor giving 10 per cent reactive drop in the primary circuit. The power for the transformer is taken from a 2200 volt 3 phase circuit supplying one of the nearby electric furnaces. While the load at times is very unbalanced it has not materially affected the regulation on the electric furnace.

The primary control panel for the transformer is equipped with the following:

3—Ammeters
1—Indicating Watt Meter
1—Voltmeter for Primary Circuit
1—Voltmeter for Secondary Circuit
1—Watthour Meter
3—Ground Detector Lamps
3—Inverse Time Limit Overload Relays
1—D.C. Undervoltage Relay
1—D.C. Voltmeter
1—Control Switch for Solenoid Operated Oil Circuit Breaker

DISTRIBUTION SYSTEMS

A portion of the distribution system is shown in Fig. 6.

The 3 phase secondary circuit is carried around the pouring pit on a bus structure in a trench. The trench is covered with heavy cast iron floor plates in which have been provided openings through which the connector plug is inserted. The plates are square and the opening so placed that the plate can be used in three positions, thereby making it necessary to have only one type of plate. The plates are so arranged on the trench that no two adjacent openings will permit of connecting to the same bus. Connection to the main bus is made through a piece of ¼" x 4" copper bus clamped to the main bus, in such a manner as to make contact with the two contact pieces on the plug, as shown by Fig. 7. The control circuits are carried in the same trench and provided with contacts to engage the fingers on the plug. To date all of this home-made equipment has proved safe and low in maintenance cost.

INGOTS

The standard Monel and Nickel ingots are known as 13" x 13" ingot, being cast in a mold 14" x 14" at top and 11" x 11" at the bottom. The mold is 5 feet long and has a taper of 1 inch in five feet. As stated before, up to this year all ingots were cast with a head measuring about 18" long, the head being removed with a saw. The average sawing time was

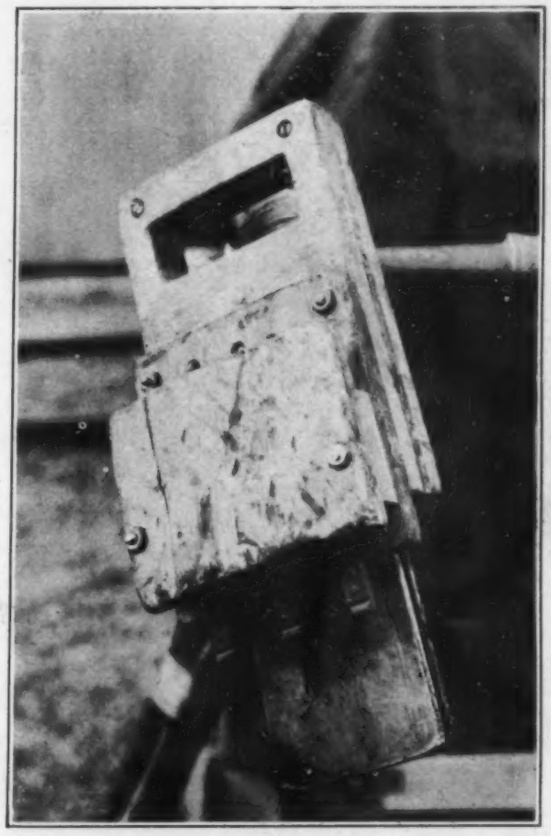

FIG. 7

about 20 minutes. The ingots produced when using the electrically heated hot top have a head averaging about 3 inches long, which is not sawed off. An ingot with the 3" head weighs 3,250 lbs.

From Fig. 2 it will be noted that the mold base sets on 100 lb. rails. The mold sets on the base with an asbestos joint between base and mold. The hot top sets on the mold with an asbestos joint be-

tween it and the mold. Under the new method the hot top has been shortened from 18 to 10 inches. The new hot top is lined with a refractory. This refractory lining is made up of 6" of No. 68 Wiggton arch brick. The other 4 inches is made up from ground fire brick and fire clay. Mortar for arch brick joints is made of chrome patch. The arch brick lining has a taper of ¾", being smaller at the top than at the bottom, to permit removing the top without injuring the lining. The life of the refractory lining is about 8 heats.

The cover shown in Fig. 8 is made of ground chrome brick, fire clay and silica of soda as a binder and is supported in a light angle iron frame. A hole is provided in the cover just large enough for the electrode to pass through.

The hot metal is poured into the mold until it stands six inches in the hot top. This accounts for hot top being lined with six inches of arch brick. The cover is placed on the hot top and metal is allowed to stand from two to six minutes, allowing the metal to cool to a temperature of about 2600°F During this time a light skull has been formed. The ingot is now ready for the electric arc. The reason for allowing a variation in time of two to six minutes is due to the different temperatures, at which the metal is poured. The operators soon learn to judge the temperature by sight.

The electrode truck, having been put in place and connected to one phase of the bus system, the elec-

FIG. 8

trode is run down by hand control until the arc is established after which it is put on automatic control. The adjusting rheostat is set for 3000 amperes. The arc, which is about 1 inch long, immediately burns through the light skull and begins to reheat the metal to a depth of about 3" around the sides, but much deeper in the center. Sometimes, in pouring, there is a leak at joint between mold and hot top. If the arc is properly handled this leak is not re-opened. However, there are cases when the leak is opened by getting metal around sides too hot. Just how deep the arc penetrates the center is not known, probably 18" or more. For nearly one minute there is considerable surging, but the arc gradually becomes settled, as a bath is formed under a slag produced

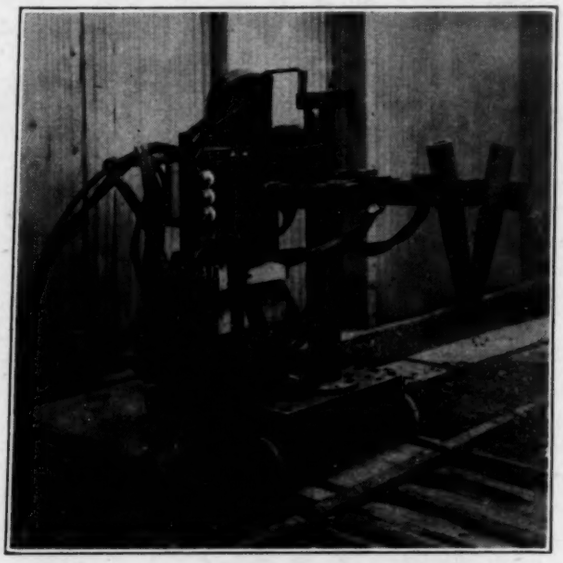

FIG. 9

by the addition of 1 to 1½ pounds of ground glass introduced through opening around electrode.

After the arc has been on from 1½ to 2½ minutes at 3000 amperes, the current is reduced to 300 or 400 amperes. At this current setting the arc burns very steadily for 2½ to 3½ minutes. During this interval it is desired to keep the slag and refractory just hot enough to force the ingot to cool from the bottom. The slag is about one inch thick and the arc at 300 amperes is about 4 inches long.

The voltage from phase to neutral, with 3000 amperes flowing and only one electrode in use is approximately 100 volts. With two or more electrodes in service the voltage from phase to neutral is approximately 95 volts, but from electrode to electrode approximately 165 volts.

The fact that the arc is left on all ingots about the same length of time makes the operation much simpler than if different times were used for each ingot. Practically all of this work is done by the regular refinery floor crew. The maintenance electrician is unusually present in case of electrical troubles. There has been very little delay or loss from electrical breakdowns.

After the arc has been on for a total of 4 to 5 minutes the electrode is withdrawn, the hole in hot-top cover is closed and the electrode truck moved to another ingot. The closing of hole in hot-top cover is very important, as every effort is made to hold the heat in the hot top.

Very little experimenting has been done with different sizes of electrodes. A 3-inch graphite electrode is used, this size being carried in stock for a half-ton furnace.

The equipment was designed for this size of electrode. Some tests have been made with carbon electrodes, but they did not stand up under the rapid change of temperature. In starting off they would break. The electrode consumption is small, about ¼" per heat.

Some heats have been made with a double electrode, as shown in Fig. 9. With a double electrode an attempt has been made to get longer life from the hot-top refractory and a shorter head on the ingot.

The disadvantages of the double electrode arc are that the equipment is more complicated, costs more to maintain and requires more time, as the arc is applied indirectly.

The results obtained by the use of the electric arc on the ingot head have been very satisfactory, in that 85% of the ingots to which the arc is applied

FIG 10

there are no pipes. With further experience, it is to be expected that the percentage of good ingots will be increased. The successful results to be obtained are largely dependent upon the judgment of the men who operate the trucks and the setting up of the molds.

Fig. 9 gives some idea of the soundness of the metal in the ingot head, when poured under the new and old methods, the ingot on the bottom being poured with the long head. Fig. 10 shows very plainly the saving in metal, which results in an increase of production of at least 20%.

Sawing is eliminated, as well as the handling of heavy scrap heads back to the furnaces.

As to the cost of operating the hot-top equipment, no additional help is required. The average power consumption per ingot is 13½ KWHR. The average cost of hot-top is 41 cents per ingot and the electrode consumption is about 4½ cents per ingot.

Fig. 11 shows four molds with ingots, which have been poured with the old style hot-top and five with the new style hot-top.

FIG. 11

There are a few points which might be cleared up in the conclusion of this paper. One is that there is no sticking of the ingot in the mold, due to the mold and hot metal being used as a conductor. So far, it has not been possible to produce a solid ingot without a head made in a hot-top. It is desirable to produce an ingot without a head and it may be

FIG. 12.

accomplished after further experimentation. The matter of segregation has not proved a serious one in the use of the electric arc on nickel and Monel ingots. The two major elements of Monel metal, nickel and copper, are completely miscible with each other in all proportions, and form a single series of solid solutions. The two minor elements, iron and manganese, are not present in excess of four or five per cent. These small amounts dissolve

completely in the nickel and copper, thus forming a quaternary solid solution alloy. Consequently, segregation is practically unknown in the refining of Monel metal. If any should occur it would be expected that the new hot-top method would tend to eliminate rather than exaggerate the difficulty.

DISCUSSION

C. S. Proudfoot*: Mr. Watson has brought up some interesting questions, and especially keeping a hot top hot by the method of a.c. current

Away back in the early 90's, the Homestead Steel Works tried out this method by the use of D.C. current in a steel ingot, and this experiment was carried out by one of our foremost metallurgists, Dr. John Unger.

John A. Seede†: When I suggested to George Schaeffer, Chairman of the Furnace Committee, at the Philadelphia meeting, that it might be a good idea to have Frank Watson deliver a paper on this subject. I hardly expected the outcome would be such a quick and thorough response as we have had this afternoon. I know I am voicing the sentiments of all present that we are privileged to listen to a first-hand account of such pioneer work. When Mr. Watson obtains the equivalent of five ingots where only four were made previously, with the expenditure of a very small amount of electricity and electrode material, he is doing something revolutionary.

There is not very much for me to discuss. I am not a metallurgist, but I am very glad to listen to this paper today and hope this is only the beginning in applications of this kind of heating in what should represent a much larger saving, steel ingots, and from the work that Mr. Watson has done, I am sure it would encourage those interested to go to Huntington and then start off with fresh courage to solve these important problems.

E. S. Jefferies‡: In 1915, at the Hamilton Works, of the Steel Company of Canada, we experimented for a few days trying to overcome piping by the use of a D.C. arc. These tests were discontinued for two reasons: Insufficient power and pressure of war work.

The hot top ingots so treated, after being split, indicated that we were sealing the top over, leaving a pocket about one-fourth way down.

I would like to ask Mr. Watson, approximately the cost of this installation and the approximate cost of each truck of the automatic type?

F. C. Watson: Total cost of installation for transformer, switchboard and six trucks is about $15,000. The trucks themselves cost about $800.

Geo. H. Schaeffer§: We are very much interested in electrical heating. This application was entirely new to us, and it is surprising to hear the comments of our chairman when he says the thing was tried about thirty years ago. Thinking over the matter it seems to me that it is a very good application of electrical heating to a special job. I think we should consider just what the job is and make note that it is monel or nickel. Nickel and monel have very good heat conductivity, and that in itself would make the application effective; more effective than if we had steel. Possibly the piping in monel, on account of that fact, would not extend as far into the ingot as it would with steel. Mr. Jefferies stated that he could not get down to the pipe by heating and it is a question whether any application would enable us to get down to the very bottom of the pipe.

Another question as to the economy of the application. Monel, in price per pound, is very much greater than ordinary steel in the raw ingot. We can probably afford to cut off 10 or 15 per cent of the ingot, and do it cheaper than applying electric heat. Mr. Seede made the remark: "It seems like we are getting something from nothing." It is true, a few K.W. applied is inexpensive, however the installation costs quite a little money, and the upkeep of the apparatus, trucks and transformers would add considerable to the overhead. I believe, also, the labor charge to be considerable, and this item is sometimes overlooked. In applying this scheme to the steel ingot, especially special steel, tool steel, steels made on special specifications, we would undoubtedly run up segregation that might cause us a lot of trouble.

F. D. Egan*: On second thought I might say a few words. I am not a metallurgist in any sense of the word and would refer my discussion to the equipment outlined for carrying on the test referred to in the paper. If you figure these trucks at $800 each and transformers at $10,000, you have an expenditure of from $40,000 to $50,000 and this amount of money at 15 per cent will give you fixed charges of from $6,000 to $7,500 annually. Practice has shown that the use of hot tops have resulted in an improved ingot, the biggest gain is obtained when the hot top is used on an ingot when casting with the big end up.

In a steel plant that is producing commercial steel, where you are working with 100-ton heats from a number of furnaces, it would be uneconomical and impossible to use the system outlined by the writer. The biggest gain in connection with hot tops is obtained when the ingots are cast with the big end up, yet it is impossible to use this practice in a commercial steel plant. The steel makers today are working for means of reducing the cost of the hot top and I am sure that in the commercial steel plant that the metallurgical department would hesitate in using this system, as it increases the cost of the hot top as well as adding a power bill to the cost of the ingots.

R. B. Gerhardt†: I have nothing to say which is very illuminating. The only thing I have in mind are some questions. I would like to ask Mr. Watson whether all production from his plant is handled in this way?

F. C. Watson: No, it is not, but it can be. We have hot top for practically all monel ingots. All nickel ingots are not, for other reasons than hot top.

R. B. Gerhardt: Your development represents what period of time?

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§Elec. Engineer, The Carpenter Steel Co., Reading, Pa.

*Elec. Supt., Bethlehem Steel Co., Lackawanna Plant, Lackawanna, N. Y.

†Asst. Genl. Mgr., Bethlehem Steel Co., Buffalo, N. Y.

F. C. Watson: Nine months. We have had as good results with nickel as monel; but we have been making most nickel with old style hot top.

R. B. Gerhardt: This proposition looks very interesting, but I am somewhat doubtful as to whether it can be made practicable for a large tonnage plant on ordinary commercial run of steel. For the special steels I believe it deserves careful consideration. It would be interesting to have some of our open-hearth men discuss this problem from a metallurgical standpoint, and I regret very much that there are not more of them here to enter into this discussion.

L. Quigg*: I do not know a thing about the nickel end of it, but there are certainly places for a limited expenditure for experiment to increase the yield and quality of steels, particularly high-grade special steels, and the operation at International Nickel should be given more than a thought by the makers of alloy steels. The difference between 6 per cent hot top and 20 per cent hot top is well worth saving. In considering the open hearth or the metallurgy of steel, there is more than the contraction or piping which takes place in both nickel and steel to take care of. The problem of soluble gases in the steel might directly affect the successful use of the arc. The steel having a greater opportunity for absorbing the gases that are pertinent to the operation in the manufacture. The operation being one of both oxidizing and reducing, the steel cannot but help contain a considerable quantity of gas. A Frenchman has estimated the volume of gas is equivalent to twice the volume of steel. When considering purely a melting proposition there are no elements in the nickel that would form a gas in the operation itself other than the gas absorbed from the atmosphere of the furnace. That brings about a condition in commercial steel that may make it a different problem. As Mr. Jefferies has stated, he only welded over the pipe. He probably filled part of that pipe but owing to the rising gas pressure was unable to completely fill the cavity. Have you split these ingots to determine their internal condition, and were you satisfied that your original sink head was not too large?

F. C. Watson: We sawed through right off below the pipe to get down to sound metal. Below that no pipe. They made the head that long. If the pipe had been that long the head would have been made that long.

The ingot weighs 3200 pounds; cut off 200 pounds. We made some and cut more off They run from 150 to 200 pounds of metal. We were experimenting in the beginning with different voltages and naturally we did not have it right and would have a short pipe and would have to cut off over 150 to 200 pounds to get down to solid metal; but now the metal is solid clear to the top.

L. Quigg: Every commercial steel or tonnage plant knows there is little time to experiment with hot tops. It would be interesting if anyone here making special alloy steels in electric furnace or small open hearth plant of 300 or 400 tons of steel a day would eventually try this out. I agree with Mr Hall that sink head practice could be resorted to to eliminate difficulties of peak conditions that exist in the pouring of the steel, which later caused defects in the steel; but I still come back to defend Mr. Egan that a commercial plant as constructed today, turning out from 2,000 to 3,000 tons of steel in every 24-hour period, hasn't any time to fool along the line of hot tops, inverted ingots, or even experiment with them without curtailing operation. But I do think the steel industry as a whole wants a development along some line to increase the yield from the ingot, and I know we all very much appreciate Mr. Watson's paper.

C. S. Proudfoot: One question that has not been explained; how the deposits from the carbon on the electrode affect the steel.

F. C. Watson: We do not find that there is any carbon deposit and we are particularly pleased of this fact. During most of the preliminary tests, the tops were cut off and sawed in two and then put through the regular tests in the laboratory. We find only a quarter of an inch of the electrode burned off in the heating of one of these hot tops. This is really an estimate; I suppose the proper way would be to weigh the electrode before and after heating the ingot top.

At the convention in Philadelphia, I was asked to say something about this, and I said we were using carbon electrode. I would like to correct this statement, because we have been using graphite electrodes. We tried the carbon electrodes, but did not want to go to the trouble of preheating. The carbon electrode would break while cooling, after the arc had been broken. That might have been due to not having the right type of carbon electrode. I do not want to cast any discredit on the carbon electrode, because we might not have had the right one; but we did take up the graphite electrode and used it without any trouble The heating and cooling does not cause any breakage. So far as any deposit of carbon is concerned, I do not think it amounts to anything, and if there is a slight deposit it will probably be in the head, which is finally cropped off.

C. J. Rodman*: I am glad the question of electrode composition came up. There is an important difference in chemical composition of electrodes, as well as advantages gained by physical structure.

Relative to the absorption of gases, as well as questions on segregation and grain size, there is a distinct difference in the metallurgy of iron and steel. I would like to draw your attention to the fact that elimination of gases is not entirely a physical phenomenon. Carbon dioxide enters into chemical combination with iron forming carbonyls, which are unstable as the iron cools, giving up CO, which may cause poor and defective ingots. The matter of grain flow is highly technical and should require further research.

The speaker has not mentioned that promising question of inductive heating, to eliminate defective ingot tops. I would like to know what is being done on inductive heating in this connection.

Dave Hays†: About fifteen years ago we tried these electric hot tops. We had 6" electrode worked up like this, but used no hot top. We lowered electrode down into the mold and we poured six ingots alternately, using electrode on three and not on the others, and then split those to see the difference in piping. The depth was about the same, but the

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shape was different. As I remember it, the shape of the pipe in the one we kept hot was like a wine glass, a little cavity, long stem and big cavity. The other was regular pipe, rather diamond-shaped affair. Volume was pretty nearly the same. We found the segregation runs higher in the top half of the ingot. Where we had .040 sulphur on ladle analysis we would get as high as .120 at the center. The same is true for manganese, phosphorus and the rest of the metal. We did not use hot top and that would make a big difference.

Another thing is that a great many customers insist on so much discard, so that would have to be rejected to the discard. That was plain carbon steel about .20. We tried some chrome and vanadium with results practically the same.

Segregation in the electrical hot top was higher than in the other top.

E. S. Jefferies: Will any hot top method prevent segregation. If you go into the electric method, I question whether it will help segregation. As I recall, it increased our segregation.

L. Quigg: The matter of segregation in going back into the metallurgy and chemistry of steel is not hard to understand. Owing to the weights of the lighter elements they would naturally float with molten part of the ingot, that is, particularly the ones that cause most trouble, viz., carbon. Sulphur segregation is negligible. An aggregate mixture of steel from the furnace will average low in sulphur. Some plants are handicapped with sulphur. Some plants run under .025 in sulphur. So that segregation of sulphur would not mean a whole lot; carbon being the principal one. Cause of segregation would be the thing to work on and that is the flowing of lighter elements towards the center. Only one way of preventing that and we have referred to it before and that is cooling rapidly. If it were possible to cool instantly there would be no segregation. The next best thing is cool as quickly as possible. The known method to do this is by increasing the mold wall thickness; some may prefer a thicker bottom and narrow top. Personally, I believe in getting the thickest wall possible, based on price of your metal, and rapidly cool to hot top, and then if this electric process would work out, keep that in molten condition to take care of pipe by filling same with molten metal. All the ingots we have split, probably thousands of ingots, in the past 15 years, point to a more thorough control of temperature. Watch the initial temperature of the steel passing from the ladle into the mold, and the control of that temperature combined with the wall thickness of the mold, increasing the rapidity of the cooling and the use of a thoroughly dried refractory sink head will minimize the segregation. We use sink head to segregate in several high-grade steels. Working on the theory that the depth of the segregate is directly proportional to the depth of the pipe, the pipe in a sink head extending not more than 15% of the vertical height of an ingot, whereas it may extend down 25% or more in an ordinary ingot.

Geo. H. Schaeffer: I do not want to get into an argument with a metallurgist, because I do not think I am competent, but it seems to me the segregation takes place not in cooling, but in melting. Take an alloy steel containing chrome, nickel, possibly a little copper, if we have different melting temperatures to get we pour in a molten condition, and you will have these different elements melting at a different time. It seems to me segregation comes in melting and not cooling.

L. Quigg: I partially agree with you. They all melt at different temperatures; therefore, they all freeze at different tempratures. But I am speaking of carbon steel. That is absolutely true of alloy steel; you can't add nickel directly before tapping and expect to have it thoroughly dissolved and then frozen uniformly throughout. This so-called segregation of manganese, nickel, chrome and vanadium is more properly termed poor distribution. Not a segregate in the sense that one refers to carbon segregation. Better furnace practice will minimize the trouble from poor distribution of alloys.

Geo. H. Schaeffer: In high-grade carbon steel, a shipment in which the carbon may be two or three points out is liable to be returned. That indicates how important it is in the specifications of the metal.

L. Quigg: Metallurgists are employed by buyers today and it behooves the steel makers to take advantage of anything to help them improve their product.

J. F. Kelly: In hot-top steel, is it not possible to have segregation in the body of the ingot? How does the hot top prevent segregation? Doesn't hot top prevent piping. It has been known that split ingots had segregation in the solid part of the steel different from ingot analysis.

L. Quigg: The segregate is related to the pipe. In the ordinary standard ingot your pipe extends down into the ingot, usually 30 per cent. Your segregate extends 10 or 15 per cent below that. It followed the pipe and also below the pipe; below the secondary pipe. If you raise the pipe you don't prevent segregation. You bring it up in the ingot permitting you to get more yield out of the ingot. You maintain that relation in a hot top which raises the pipe. It don't eliminate it, but brings it up nearer the top of the ingot. The distance between segregate and bottom of the ingot, in standard ingot, is probably 40 or 45 per cent of the ingot length. If you split ingots you know from the bottom to the segregate there is only about 40 or 45 per cent not showing segregate. In sink head steel this distance is probably 60%. Therefore, the advantage of sink head is that it reduces the segregation in its vertical relation to the ingot. Bearing in mind that it is impossible to prevent some segregation, unless it were possible to cool the steel instantly.

F. C. Watson: I would like to say this; that you may find your first trials are not very encouraging. We had that result, and after many trials began to get very discouraged, but the main trouble we found was that the operators did not watch closely what they were doing. My argument being, if they could make 10 good ingots they ought to make 500 or 1,000, because it is practically the same operation. I could see no reason why they could not make all ingots perfect if given the necessary attention. However, we got a little discouraged in the beginning. I would like to say this idea was first suggested by our general manager, Mr. Shoffstall, who is a metallurgist, and he had the faith it could be done. We do not think that our operation is per-

fect, and there was a little hesitancy on our part to present this matter, as somebody might get the idea we thought we had the thing entirely perfected. We are satisfied with the results we have gotten, but think we can get better results. We are learning every day and would like to see it 100 per cent. We believe more can be done with the electrically heated hot top.

There is a whole lot more to be gained by seeing the process than by talking about it, and if any of you can get down to Huntington we would be glad to have you.

Improvements at the Plant of the Carpenter Steel Company During the Last Decade

By E. J. POOLE*

A score and ten years of experiences in steel mill practices form one of the most interesting chapters that the Iron and Steel Engineer has been permitted to portray for some time. Mr. E. J. Poole, General Superintendent, The Carpenter Steel Company, Reading, Penna., and one of the most successful steel producers in this country relates the developments that have occurred in his particular field, stressing the fact that electricity has been responsible for quite a number of the improvements and developments at The Carpenter Steel Company as well as the Iron and Steel Industry.

Mr. Poole's article leaves no misunderstanding that electrification in the Steel industry will be complete in the course of ten years, since in The Carpenter Steel Company's plant alone the increase in the power and light requirements during the last ten years was just about 1,000%.

I KNOW that the paper is supposed to cover the subject of "improvements at the plant of The Carpenter Steel Company during the last decade" —but like most men who deliver papers of this kind, I have covered a much greater period; in fact, I propose, with the help of some authorities, whom I shall quote and my own knowledge to make a quick survey of the period since the erection and operation of the first central station in 1882. I have been lead to do this because of the fact that a short time back I had the extreme pleasure of listening to an

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address by Mr. Charles Penrose, Asst. General Manager of Day & Zimmerman, Inc., which was delivered at a meeting of the Pennsylvania State Chamber of Commerce at Harrisburg. To me, this was a most interesting talk, possibly because of the fact, that like some who are here tonight, I have seen and gone through the things of which Mr. Penrose writes, so, with your permission, I shall quote from Mr. Penrose's address:

"With a United States population of 50 millions, with Chester A. Arthur, of New York, in the White House, as our twenty-first President, and with Governor Hoyt presiding at Harrisburg over the destinies of Pennsylvania, 1882 was an era of 3-cent postage, of gas lighting, of cobblestones and horsecars, of soap-box oratory and torchlight processions, of wax works and newspaper almanacs, of balloon ascensions and side-wheel excursion boats.

"It appears to us, in retrospect, as an age of picturesque simplicity in everything save language and architecture. The Forty-seventh Congress was in session and every United States Senator got an allowance for stationery and newspapers of $125 per annum. The Union had admitted 38 states. Pennsylvania was still in dispute over her boundaries. The public lands were still being disposed of in homestead sites. Civil War pensions, stamp taxes and the reform of the coinage were in the public mind. The Greenback Party was still in evidence; had a State Governor—in the State of Maine. Timber still was being cut on an extensive scale in Pennsylvania. Fourteen canals were yet in service within the state and canal boat traffic was something to write home about.

Lace curtains at the front parlor windows, illumined fitfully by the flicker of the street gas lamp without, were symbolic of a domesticity in 1882 that knew not the electric light; the radio; hardly ever the talking machine; very rarely a telephone; but invariably a looking glass from floor to ceiling in the front hall, put there by tradition; and never an automobile. The horse still was king. The genus chauffeur was yet unborn; gasoline was a by-product; the garage, the chain grocery and the 'Naborhood Store' were yet to become controlling features in our suburban landscapes. All of this only in 1882."

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In addition to that which I have quoted verbatim above, Mr. Penrose gave some interesting facts gleaned from the Philadelphia Public Ledger in the year of 1882, at the end of which he calls attention to the fact that—

"Not a steam turbo-generator was in operation. Not a kilowatt-hour of electrical energy was transmitted over the steel towers of the transmission lines of the future, to furnish the sinews of power to Pennsylvania industry. Not a horsepower of energy from Pennsylvania's rivers was harnessed in that little-understood form of "wizardy."

"Electricity"

Many of you younger men in the audience tonight may wonder why this particular part of Mr. Penrose's address struck the writer as forcibly as it did. Well, I don't blame you for that, but if you stop to consider the matter, you will realize that it was about the time he writes of, or even before—let us say about 1879—when Edison gave to the world the incandescent lamp, which was destined to be the forerunner of this tremendous power, in which you men here tonight are primarily interested. The writer was just beginning to take an interest in things, other than those connected with the nursery. At about this time the writer lived in a little place in New Jersey called Pompton, where, some 25 years before, one of the very early steel plants of the country had been started. This was known as the Ludlum Steel and Spring Co. The writer recalls very vividly the many times when he, dressed much the same as Huckleberry Finn or Tom Sawyer is pictured to us, stood at the portals of what to him, at that time, was a monster plant, and with both eyes and mouth wide open, watched this wonderful machinery seemingly crush and form this hot material, in various ways.

As stated above, this plant had been started some 25 years previous to the time the writer is writing about, but I question very much whether, in that period, there had been any changes or any material improvements in the plant as originally laid down. If memory serves me right, the rolling mills were still of the 2-high character and were being driven by water power. It is also my impression that most of the hammering was being done by the old style belt-driven tilt hammer, although I am under the impression that it was about this time that the first improvements were being installed, namely, a small, but what was considered at that time, a large boiler and one or more steam-operated hammers for the hammering of the steels manufactured by this company.

There are many things connected with the operation of this plant of which I could tell you—these, of course, have been told me by others—in the years that have followed, and I am sure they would prove of interest here tonight, but there is hardly time for this, therefore I must pass on, skipping the impressions that, as a youngster, I received during the time spent—after leaving Pompton—at the mines of the Cooper-Hewitt Co., at Sterling Lake, N. J. It may not be amiss, however, to say that this section of the country at that time was not the most desirable place in this most wonderful country of ours to live. In fact, my memory seems to recall hearing those older than myself, who were forced to live there at that time, calling it "the most God-forsaken place in the world."

After this period of retirement from active contact with the world, my parents, fortunately for the writer decided that we should move to Paterson, N. J., and there again I came in contact with the actual manufacturing of steel through the fact that many of my relatives were connected with the Passaic Rolling Mills, which, at that time, were doing considerable rolling of iron and steel for bridge, structural purposes—and again—though not at this time—dressed like either Huckleberry Finn or Tom Sawyer, I stood amongst rolling-mill machinery and must confess, not without some fear, and watched what was to me—marvelous machinery perform the tasks that they had been built for. Of all the machinery installed there, the thing that impressed me most was the "hot saw," which was used in cutting off the ends or cutting to length the material, after the rolling operations; and it goes without saying, of course, that this saw was not driven with a motor, but by the usual methods of that time—"a small steam engine."

Again, let me say that I might dwell for some time on describing this particular plant, but I must forego this and instead give you a brief description of the first plant in which the writer performed any of the many tasks to be found at steel works. This was the Spaulding & Jennings Works, Jersey City, N. J. This was during the early part of 1890. At that time, this plant was like many others throughout the country, deriving its entire motive power from steam-driven units which were scattered throughout the plant, in what seemed then to be the most convenient places, but in addition to these steam-driven units, we had at this plant, our full share of those implements of waste known then and still known as Pulleys, Hangers and Shafting.

So far as I can recall the only electricity being developed or used in this plant was derived from a small generator driven from a main shaft with a belt, the size of this generator, I do not recall at this time, but you electrical men can judge for yourselves when I tell you it furnished the power for about 8 or 10 of the old style carbon arc lights, much of the light required at the rolling-mills, hammers and in the cold rolling plant was furnished by the old-time coal-oil, cotton-wick torch light.

In passing, permit me to say that it was about this time that the first trolleys were used to replace the old horse cars at Jersey City, and the writer remembers quite well the many times it was necessary for the passengers to get out to lighten the load, so that the cars might ascend the grade which was then and is probably still today, known as the Montgomery Street Hill. The writer is not quite clear in his mind as to whether this first tryout of the electric trolley was a storage battery or an overhead installation, but is inclined to believe that the first tryout was of the storage battery type, which was supplanted very shortly after by the feed wire trolley type of transportation.

"The writer spent some 14 years at the Spalding & Jennings plant, and can recall with what great satisfaction his part in installing the first improvement in electrical energy. This installation being placed in operation in the early part of 1898 and consisting of a generator connected direct to a Ball & Wood engine. I believe this was about a 200 KW engine.

There were no other changes made at this plant until about 1902, when an addition to the plant was

erected in connection with which there was built what was then a modern industrial electric generator.

In 1904 the writer severed his connection with the Spalding & Jennings plant and came with The Carpenter Steel Company. Conditions at our works at Reading, so far as motive power was concerned, was much the same as I have briefly described as those that existed at the plant of the Spalding & Jennings Works.

Our electrical generating equipment consisted of:

40 HP motor-generator used for making power to drive two 24" gauge mine type locomotives for yard haulage, which was also belted to engine driven line shaft.

3 HP AC motor driving shears at 8" mill.

10 HP AC motor in No. 1 mill, driving draft fan for hammers and crucibles.

The electricity which we required for lighting purposes being purchased from the Metropolitan Edison Company.

In that part of my paper which follows I shall endeavor to give you, as clearly as I can, the condition of our plant regarding motive power, both steam and electrical, in 1904, and the changes which have been made during the last two decades.

In 1904 we were generating steam in two separate boiler-houses, known as No. 1 and No. 2. No. 1, being the original boiler-house and consisting of 10—72" diam. x 18 ft. long Coatesville horizontal tubular type boilers, with a rated capacity of 150 HP each. This was increased in 1906 by the addition of two DeLaney boilers of the same general type and HP rating. This plant remained the same from the time of the addition of the two boilers just mentioned, until its dismantlement early in the year 1920.

Boiler plant No. 2 consisted of 6 Bigelow-Manning vertical tube boilers containing 284—2½ diam. tubes—15 ft. long, with a rating of 250 HP each. This boiler-house also remained the same, except for some minor changes, until it was dismantled, along with boiler-house No. 1 early in 1920.

From the foregoing, you will note that the only additions to our boiler capacity from 1904 until they were dismantled in 1920, was the two DeLaney boilers, erected in Boiler-House No. 1, and may I say right here that the purchase of these boilers was not occasioned by the fact that we needed additional boiler capacity, but was brought about because of the extremely bad condition that the boilers, as well as the engines around the plant, had been allowed to get into previous to the time that Mr. Phillips (Master Mechanic) and the writer became connected with the company.

This, I think, was clearly shown by the fact that but a short time after they were installed, we found it quite easy to carry this load by using but **eight** of the return tubular type boilers and from **three to four** of the Manning boilers in the other boiler-house.

While the steel trade was at this time beginning to realize the importance of carefully watching their power units (not near the attention was paid them as is the practice at the present time) some idea of the conditions that existed at our works (and this was by no means the only plant that similar conditions existed) can be gathered by the condition in which the writer found the engine driving our 16" mill. Shortly after my arrival in Reading the roller on this mill complained that it was impossible for him to roll a bar on certain sizes of flats longer than 20 or 25 feet, where, if proper practice had been followed, this should have been rolled in lengths of at least 100 feet.

After a few preliminary tests, the writer decided to tear down and re-assemble the engine connected with this mill. After reconditioning the valves, pistons, cross-heads, crank pins and other parts of this engine, we decided to line it up with the mill, and found that when a line was drawn parallel to it, the end of the mill was shown to be nearly 6" out of line with the engine driving the mill.

This is recited here simply to show you how little attention was paid in many plants in that day to what, to my mind, is a very important part of our industry. There were many instances of this same kind during this particular period.

To revert again to the boilers, let me say that the writer was not as familiar with their condition as was Mr. Phillips, but upon inquiring from him recently as to what their condition was in 1904, I received an answer in one word and believe that it clearly expressed the condition that we were confronted with. To those of you here tonight who know Mr. Phillips—it hardly seems necessary to say that that word was "rotten."

It might be of interest to say that at this time the connected load for which these boiler-houses furnished power in 1904 was estimated to be about 3900 IHP and consisted of many small steam power-driven units stuck in out-of-the-way places throughout the plant.

Our first work was to reduce as much as possible the losses occasioned by these small units and the tremendous amount of loss due to the many pulleys, hangers and shafting which we had throughout the plant. This, we did, and without burdening you as to how it was done, I am glad to say that in 1920, when the two boiler-plants under discussion were dismantled, we had reduced our connected HP load until it consisted of less than 3500 IHP. This, in spite of the fact that during the period under discussion, we had increased our output more than three times. Of course, our increased use of electricity accounted for our ability to reduce our steam-connected load and you will hear further concerning this when the question of the development of our electrical energy is taken up later on.

Had we been allowed to follow our own inclinations and plans we would have gradually replaced all of our steam-driven motive power units with electrical-driven motors, but due to the conditions arising during the war, we were forced, because of the fact that the electrical energy was not available, to start the designing and erection of a new boiler plant which, owing to the many delays encountered during the war, the signing of the Armistice and other things, was not ready for operation until the early part of 1920.

This new plant was located on what is known as our West Shore property and the installed capacity is 2556 BHP in six 426-BHP units. These are water-tube boilers equipped with forced-draft stokers. The builders recommend operating these boilers at twice the 2556-BHP rating, or at 5112 BHP, and the stokers are designed for 5112 continuous BHP.

Moreover, for peak-loads of one hour duration or less, the boilers and stokers are good for two and one-half times the 2556-BHP rating, or 6390 BHP. I understand this is usual modern power-plant practice. The boilers deliver steam at an average of 145-lb. gauge-pressure in the mill.

On April 6, 1917, we had installed in our plant a total connected load of 3940 equivalent indicated horse-power in engines, hammers, picklers, etc.

I should like nothing better than to fully describe this boiler plant, which is what might be termed—"a modern industrial power plant"—however, time will not permit and I must pass on—but I cannot do so without mentioning a condition which we found, after we had installed and used for sometime (steam flow meters) in connection with the steam used by our various departments.

Previous to the building of the power plant, we had apportioned our steam by what is usually called and I think very appropriately—"the rule of thumb method"—in other words, some men or group of men estimate about the steam that each department was using per hour of operation and that particular department was charged accordingly, and you can, I am sure, appreciate our surprise when we found that after the new boiler-house was erected and the steam flow meter in use, it was found that we were actually using a little more than twice the amount of steam we were charging out.

It naturally follows that when we got the cost per 1000 lb. of steam generated under the old conditions our costs were unusually high. For that reason, we can give no accurate comparisons of our steam cost under the old conditions as compared with the new. However, we are following very closely our costs on the generation of steam in our present boiler-plant and in that connection it might be of interest to you, gentlemen, were I to give you part of a report prepared for us by Freyn, Brassert & Co., of Chicago, Ill.

Present Unit Cost of Steam

"Exhibit A" is a derivation of the cost of steam per thousand pounds, generated at the West Shore boiler house. This is based on 14,500 b.t.u. coal at $5.00 per ton delivered—this cost being anticipated for the next few years. As coal has exceeded this cost in recent years, the derived cost of steam is somewhat less than indicated in your records. The fuel cost of this steam is based on a boiler efficiency of 68 per cent. This figure is indicated by past records of evaporation and coal consumption, and is substantiated by flue gas temperatures and observed waste gas analysis. A fuel cost of $0.274 per thousand pounds of steam is indicated. Other operating expenses and charges as taken from cost records, amount to $0.201 per thousand pounds, giving a total cost of $0.475 per thousand pounds. This figure includes no fixed charges on boiler plant.

This figure of $0.475 per thousand pounds represents closely, in our opinion, the steam cost under the stated single turn 45 per cent operation conditions. If the output of the steam plant were reduced by reduction of present uses, the savings incident to such reduction would not amount to the full $0.475 per thousand pounds. Much of the general expense would remain largely intact. The savings would accrue through complete elimination of the fuel cost of the steam saving, plus a small portion of the general cost. We have, therefore, placed a value of $0.30 per thousand pounds as representative of the saving accrued through reductions of steam consumption so long as the present steam plant is maintained and operated. The balance of $0.175 per thousand pounds of steam saved goes to cover the higher unit cost of the remaining steam generated due to its lesser amount. Likewise, in the case of 100 per cent operation, the steam generated, over and above that used for 45 per cent operation, will cost but $0.30 per thousand pounds. The resultant average unit cost for the larger quantity of steam generated for 100 per cent operation then becomes $0.419 per thousand pounds.

Before leaving this question of boilers and steam, let me say to you, Engineers, that the simple erection of a boiler plant generating station, or the installation of motors or engines does not mean that a saving is to be made. Whatever is built must be carefully handled by the men who are to operate it, after it is built, not only that—you must sell the importance of it to everyone connected with the works which it is to serve.

Let me give you just a little illustration of what can be done when your operating end is working in close conjunction with your power men.

In our wire department, we have a half dozen pickling vats. Owing to the nature of our work, it is necessary that these men start several hours before the regular day turn, consequently the steam for these vats was being used freely from that time until 2 or 3 o'clock in the afternoon, when these men completed their day's work. For quite some time no attention was paid to the fact that these men had completed their work so early in the day, and the steam was allowed to flow as usual through the entire amount of pipe required to carry it to its place of use.

Sometime back we decided we might save some money, if the steam was shut off at a point near the main line, immediately after the men had completed their day's work and from actual records from our steam flow meters, we have found that the cost of steam used in doing this pickling work has dropped from an average of about $5.00 per ton to less than $2.50 per ton.

This little illustration is given you to show the importance of following up and selling any improvement that may be put to the men who actually operate.

This hasty review of our boiler and steam units has consumed much more time than the writer had anticipated, and I am sure that our electrical engineer—Mr. Schaeffer—is wondering when something definite is to be said with reference to "Electricity"—so let's pass on to that very interesting subject.

As previously mentioned our electrical equipment at the beginning of the period under discussion was conspicuous by its absence. Inasmuch as it will not take much of your time, I shall give the complete list, as follows:

1905—Lighting—all electrical—consisting of about 23 arc lamps and 200 incandescent lamps. No extension lamps—oil torches used instead.
30 HP AC motor driving two Pedric air-compressors—located in old machine shop.
40 HP motor-generator used for making power to drive two 24"-gauge mine type locomotives

for yard haulage, which was also belted to engine driven line shaft.

3 HP AC motor-driving shears at 8" mill.

10 HP AC motor in No. 1 mill, driving draft fan for hammers and crucibles.

With this very modest beginning we started in 1906 to replace the many small steam-driven units in our plant. The first installation was a 75 HP motor used in driving our polishing and tempering departments. This, to us, at that time, was considered a large motor. There were other motors installed during this year and the work was continued in the years that have followed.

It is not the writer's intention to tire you with needless details. For that reason we will make no mention of changes made during the years 1906 to 1912. It might not be amiss, however, to mention that the changes during this period consisted mostly in replacement of the small steam-driven units. However, the writer feels that he would be doing our good friend—George Schaeffer—an injustice were he to skip over the last 12 years in this same way. Will, therefore, ask your indulgence while we give in part, at least, some of the electrical changes that have been made at our works during the time mentioned above. This list is as follows:

Replacement of old type arc lamps by flaming arcs.

Increased size of transformer-sub-station from 150 KW to 400 KW—100 HP motor for end of 10" mill.

Replaced vertical engine in wire department—driving wire mill polishers and temperers, by individual drive and group drive.

Installed 300 KW DC generator and distribution panel.

Installed open-hearth with overhead electric traveling cranes.

100 HP motor for bull block.

200 KW synchronous motor for air compressor.

Replaced engine located in old machine shop used to drive cold rolls in wire department by motors.

Motorized inspection department and equipped with overhead electric traveling cranes.

Increased capacity of power sub-station to 1000 KW.

Installed meter house.

High tension changed from 2,200 to 13,200 volts

Installed power distribution system.

Motorized machine shop and blacksmith shop.

Started first 6-ton Heroult furnace—February, 1917.

Started second 6-ton Heroult furnace, June, 1917.

Installed 2,200-volt power equipment.

Installed 600 HP mill drive—20" mill.

Installed 200 KW motor generator.

Installed "C" and "D" 6-ton Heroult furnaces.

Installed additional overhead electric traveling cranes.

Installed tower sub-station to take care of overloads prevailing on the different distribution lines.

Installed two 10-ton overhead electric traveling cranes in forge department.

Installed two 206 HP motor-driven air compressors.

Installed magnetic clutch on 10" and 12" mills. Since 1923 we have not increased to any great extent our electrical equipment, our work being mostly along the lines of bringing up to date that equipment which we had installed in the years past.

It might be of interest to you, gentlemen, to know that from the three motors, with a rating of 43 HP, which we had at work in 1905, we have increased our use of electrical energy, until today we have approximately 550 motors, with a motor HP of about 7500, in addition to which we have a furnace load of 6500 HP, or a total connected load of 14,000 HP.

Like most plants that have grown as has the Carpenter plant, our records of the years that have passed are not as complete as we would wish for, however, there are some that are, indeed, interesting and among them is one giving the amount of electrical power used in 1910, the first year for which we have records, upon which we would care to depend. The comparison of the year mentioned, with our peak year 1920, was most interesting to the writer and may be of some interest to you, gentlemen.

This comparison was as follows:

	1910		1920
Lighting	10,000 K.W.H.		50,000 K.W.H.
Power	14,000 K.W.H.	vs.	2,350,000 K.WH..
	24,000 K.W.H.	vs.	2,400,000 K.W.H.

Your attention is called to the fact that during the 10 years which intervened between the first and last record just read to you the use of electrical energy by the Carpenter Steel Company increased parctically 100 times, and had it not been for conditions forced upon us by the World War, our increase would have been much greater than that which we have shown.

Undoubtedly you have noted the fact that the writer has not, in any way, referred to the purely mechanical improvements that have been made at our plant during the period under discussion, nor gone into details with reference to the steam actuated units that have been retained by us, however, the writer would like to mention the fact that in 1913 we installed, I believe, what then was and I believe is still today—the only turbine driving a rolling mill. A paper describing this unit in detail was presented before the Western Engineer's Society early in 1914. If there are any that might be interested in this installation, they, I believe, can secure copies of this paper from the Society mentioned.

Would also like to make the statement that wherever we have retained steam as the motive power, we have either put in new or rebuilt in their entirety, the engines used.

The writer has been forced to refrain from going into detail in connection with these subjects in order to hold this paper within reasonable limits and thus avoid tiring you, gentlemen, more than was absolutely necessary; however, either the writer or some one connected with our company will be glad to give anyone interested any information which they may desire in connection with any changes or improvements that we have made at our works here, at Reading.

Now, gentlemen, the time comes when there must be an end to all things, and this paper is no exception to that rule, therefore, let me, at this time, thank you for your patience in listening to this very sketchy paper presented to you tonight.

Merchant Mills

By D. W. BLAKESLEE*

IT IS usually desired to roll a wide variety of finished shapes on a mill. Such a mill, where the rolls may be changed frequently so as to turn out different shapes, is commonly called a merchant mill. It may roll angles, beams, channels, flats, rounds, squares, etc. Twenty inches is about the upper limit of this class of mills. It may be seen that there is no line of demarkation between merchant mills and some of the other types of mills. On the other hand, there is quite an overlapping, and the designation cannot be exact.

The size of the merchant mill is the diameter of the finishing rolls, although the roughing rolls may

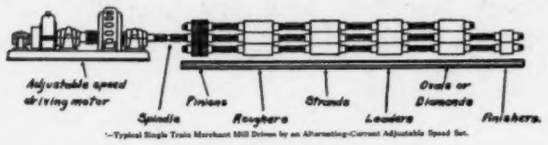

FIG. 1.

be larger. Of course, an independently driven roughing stand may be designated as a mill of whatever size the diameter of the rolls. The layout of a merchant mill depending upon its arrangement may be termed Belgian, combination, guide, loop, etc., to distinguish it from other mills of the same size or location.

The merchant mill passed through the same historical stages of development typical of all rolling mills; starting with a single stand, two high, continuous rotation, and hand manipulation of the steel; three high, to save handling; multiple stands, to increase tonnage by use of larger billets. The modern development of the single train mill is indicated in Fig. 1. The number of stands in the train may be more or less than that shown, but five is the usual

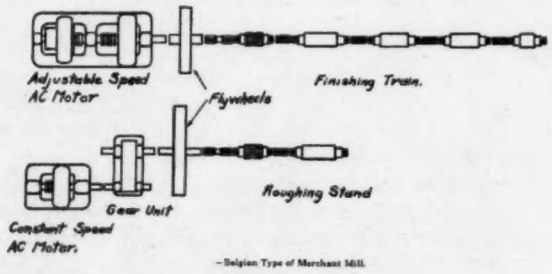

FIG. 2.

number for mills with finishing rolls of 8 in. to 12 in. The stands may be called roughing, leading, oval or diamond, and finishing.

This type of mill requires quite a number of men to enter the steel between the rolls and catch it as it comes through, passing it from groove to groove and stand to stand. The metal must be in line with the groove it is to enter or delay will result. A certain amount of time consuming care is therefore required for hand mill operation; the relatively low mill speed required is only economical when rolling tool steel or other special product. To obtain greater output by higher speed of rolls, guides are provided before each groove. These guides are castings made with a tapered opening, the smaller end being next the rolls and of about the shape of the section of the metal at that stage of the rolling. The guide is in two parts, so that adjustment may be made to compensate for wear. When they are used the mill may be termed a guide mill.

With the change of product and the change of rolls, the speed usually must be changed. Roll speeds are limited by two things; suitable speed for entering the material between the rolls, and time for handling the metal. As the roughing stand requires a relatively low speed for the first reason, and as the limitation imposed by the second factor is of decreasing importance, it is much more economical to drive the finishing train at a higher speed than the roughing stand. This arrangement is the so-called

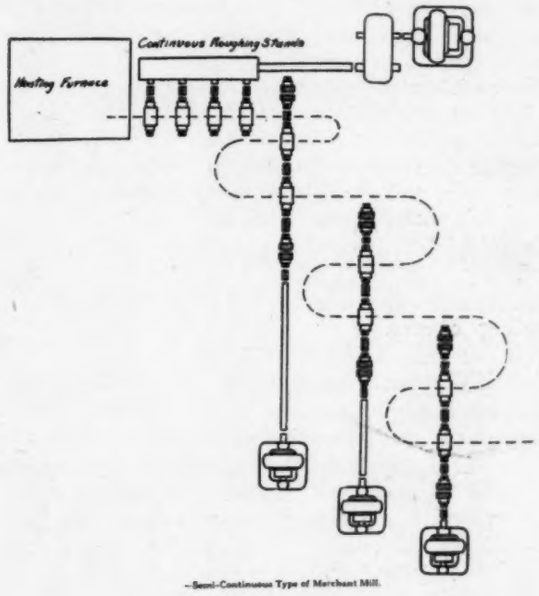

FIG. 3.

Belgian mill. In the early mills of this type the roughing stand was driven by rope transmission by the engine connected to the finishing train. Electricity provides a more flexible and economical arrangement by the use of two motors, as shown in Fig. 2.

The next steps to increase the output of merchant mills were (1) to roll the piece in more than one finishing stand at a time by looping the metal when it was rolled to sufficient length and section, and (2) to provide a number of roughing stands in series, each with but two rolls and to pass the material through them continuously. When both of these arrangements are incorporated in one mill, it is known as a combination mill, as it is part continuous and part looping. Such a layout is shown in Fig. 3. An eight-inch mill of this type may be driven by one 1250 h.p., and two 360 h.p. motors.

*Elec. Engr., Jones & Laughlin Steel Corp., S. S Works Pittsburgh, Pa.

As intimated above a merchant mill may roll a product which, because of its shape or relatively large section, cannot be looped. When this is the case, the minimum of labor may be employed by using what is commonly known as a cross-country mill. See Fig. 4. The stands are in series, as in the continuous mill, but they are relatively much further apart, so that a piece is in but one stand at a time. Roller tables move the metal from one stand to the next. The stands need not be all in tandem, but may be arranged to suit local conditions. A modern, twelve-inch cross-country mill may be driven by two 1500 h.p. adjustable speed sets of constant horse-power type.

Merchant mill design requires speed adjustment of the rolls in all except roughing stands in Belgian and combination mills. The reduction in speed may be thirty to fifty per cent. In many cases, where the speed is reduced there is required a greater torque as the section of the metal being rolled is reduced much more at each pass. Fig. 5 shows a 400 h.p. d.c. motor, designed for such service in connection with a nine-inch merchant mill in the works of the United Alloy Corporation at Canton, Ohio. When but one direct current motor drives a mill, or it is driven

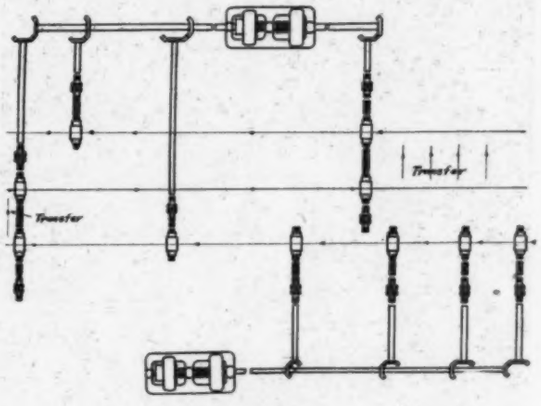

FIG. 4.

by two motors which can have the same speed variation on the lower part of the range, a cheap drive is obtained by using a synchronous motor-generator set; the motor speeds being reduced below the full field speeds by reducing the generator voltage by field control. This arrangement gives constant horse-power at and above full field speed of the motors and constant torque below that point. The Driver Harris Co. have such a mill with this sort of drive: one 800 h.p. motor has speeds of 350 to 700 r.p.m., and one 500 h.p. motor has speeds of 300 to 600 r.p.m. The speeds of these motors are reduced below 350 and 300 r.p.m., respectively, by reduction of the excitation of the generator.

About 90 per cent of electrical merchant mill drive is by alternating current. Two kinds of a.c. drives are used; frequency converter set, and synchronous converter set. In Fig. 6 is shown the 500 h.p. frequency converter, constant horse-power, adjustable speed set driving a ten-inch monel metal mill in the works of the International Nickel Co., at Huntington, W. Va. A synchronous converter set of 3000 h.p., adjustable speed, constant horse-power, driving the twelve-inch mill of the United Alloy Steel Corporation at Canton, Ohio, is shown in Fig. 7.

In arrangements where peak loads are imposed upon the mill, flywheels are used to reduce the momentary demand upon the power plant and to keep down the size of the motor required. When the mill speed is 100 r.p.m. or more, it is preferable to have the flywheel mounted on its own bearings, and run at

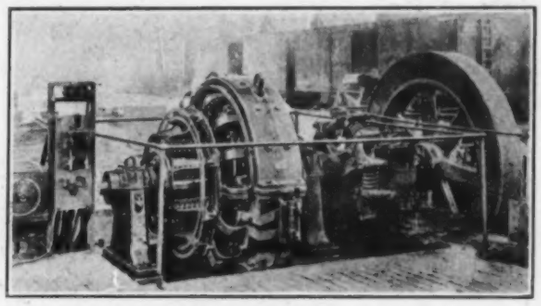

FIG. 5.

the mill speed. When the mill is driven by a higher speed motor through gearing, it is economical to use wheels of small diameter on the pinion shaft of the gear unit which must be designed to handle the peak load of the mill. Regulation by slip resistance is employed for alternating current drives. For motors of 600 h.p., and above, the liquid slip regulator is recommended, and for those below 600 h.p., magnetic control with permanent slip resistance to give 10 and 15 per cent slip at full motor load.

There are quite a number of factors which determine the size and type of the driving unit for a mill:

1. Layout.
2. Size of metal entering mill.
3. Finished product.
4. Number of passes.
5. Cross-section of each pass.
6. Speed of mill (per cent of time at each speed, if more than one).

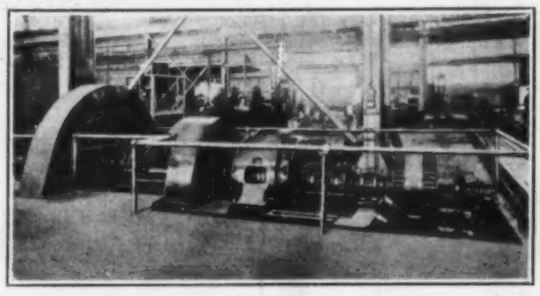

FIG. 6.

7. Size of rolls.
8. Average tons per hour.
9. Maximum tons per hour.
10. Number of pieces in stands simultaneously under maximum conditions.
11. Methods of manipulation and transfer.
12. Desired type of drive (direct connected, gear, rope, etc.)

13. Chemical content of metal.
14. Temperature of metal.
15. Energy available.

From the above it may be seen that there are at least 15 things which bear upon the amount of energy consumed by the mill drive, but the elongation is usually taken as an index. In Fig. 8 is shown the relationship between the elongation and rate of

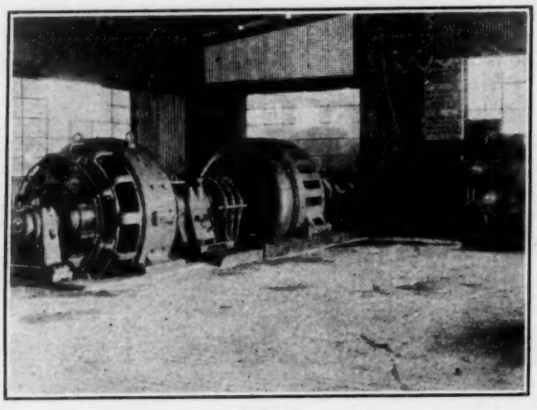

FIG. 7

energy consumption for merchant mills. This is an average curve which was based upon tests made on a number of merchant mills. To indicate further the effect of elongation, the results of tests on four merchant mills are shown in Fig. 9. The 8 in. mill takes 2½ in. x 2½ in. billets and rolls them into furnace bands. The 9 in. mill takes 6 in. x 3 in. x 22 to 30 in. and reduces to ⅜ in. or 1⅜ in. rounds or squares; also takes 3⅛ in x 4½ in. x 22 to 26 in. and rolls to ⅝ in. x ⅜ in. or 1½ in. x 1½ in. flats. The 10 in. mill starts with 6 in. x 3 in. x 22, 70, 30 in. and finishes ¾ in. or 1-13/16 in. rounds or squares, or 2 in. x 9/32 in. or 4 in. x ½ in. springs, or 1 in. x 1½ in. or 2½ in. x 1⅜ in. flats The 20 in. mill rolls billets 8 in. x 6 in. x 22 to 62 in. down to 1⅜ in. or 5 in.

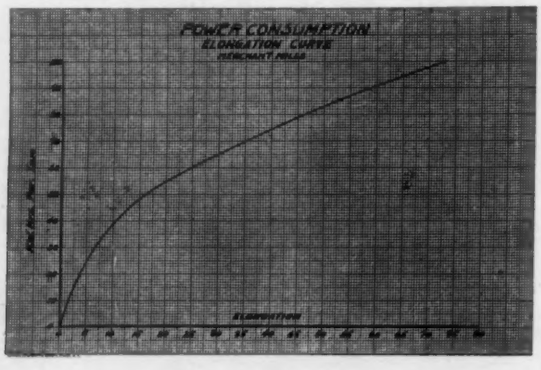

FIG. 8.

rounds or squares; it may start with 3⅜ in. x 8 in. x 24 to 30 in. and finish 2 in. x ⅜ in. or 6 in. x 2 in. flats.

Although no auxiliary drives are used in the merchant mill rolling process (except on the tables of the cross-country mills), considerable auxiliary equipment is used before and after the rolling. Most of the motors on this equipment are mill type direct current motors with reversing controllers. Standard industrial type motors are used on shears and saws; when alternating current is available standard squirrel cage induction motors are used on shears. To give a general idea of the auxiliary drives the following lists are given for two mills:

14 In. Merchant Mill

Application	No. Mot.	H.P.	Winding	R.P.M.
Furnace charging tables	2	20	Cpd.	600
Furnace charging conv.	2	20	Cpd.	650
Furnace cross pushers	2	30	Ser.	525
Conv. furnace to mill	1	30	Cpd.	550
Connecting tables	3	20	Cpd.	650
Skew "Y" tables	4	60	Ser.	475
Hot saw	1	40	Cpd.	600
Hot saw lift	1	6	Cpd.	725
Hot runout rolls	1	100	Sh.	400/800
Kick-off	1	25	Cpd.	600
Packing	2	12	Cpd.	710
Lift lever	4	12	Cpd.	710

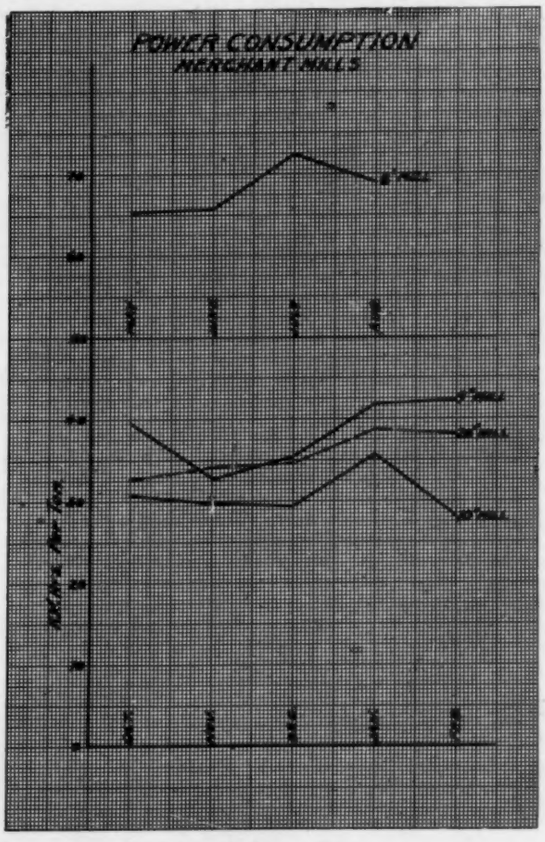

FIG. 9

Cold runout	4	30	Cpd.	550
Eccentric shaft	4	30	Cpd.	550
Bar shears	2	20	Cpd.	750
Shear table kick-off	2	10	Sh.	600

12 In. Merchant Mill

Furnace pushers	2	20	Ser.	600
Furnace blowers	2	35	Sh.	500/1500
Conv. furnace to mill	1	30	Cpd.	550
Shears	1	20	Sh.	750
Roughing mill conv. tables	3	20	Cpd.	650
Rev. "Y" transfer tables	4	60	Ser.	475
Hot runouts	1	60	Sh.	500/1000
Packing	2	60	Cpd.	725
Cold runout	4	30	Ser.	525
Assembly tables	2	30	Ser.	525
Rack and lift levers	1	50	Cpd.	585
Carry over racks	4	80	Cpd.	480
Kick-off	1	10	Sh.	600
Bar shear	2	20	Sh.	750
Shear table kick-off	2	10	Sh.	600

In spite of the fact that a great number of old steam-driven mills have been electrified, and that all new merchant mills are electrically driven, there still remain some mills with steam engines which will eventually be replaced by motor drive to obtain all the advantages procured by electrical operation. There is, perhaps, more to gain by motorizing a merchant mill than any other, because of the additional advantage of flexibility of electrical control.

To indicate the sizes of motors, with their speeds, used by a great number of organizations on their merchant mills of the sizes commonly employed, the following list is presented:

Inch	H.P.	R.P.M.	Volts	Cyc.	Drive	User
8	300	500/300	2200	25	Direct	Bethlehem Steel Co.
8	300	865	2200	25	Direct	Bethlehem Steel Co.
8	300	450	2200	60	Direct	Llewellyn Iron Wks
8	300	315/630	230	D.C.	Direct	Donner Steel Co.
8	400	400/450	220	D.C.	Direct	Illinois Steel Co.
8	450	354/230	2200	60	Direct	Bourne-Fuller Co.
8	500	435	440	60	Rope	Carnegie Steel Co.
8	500	306	2200	25	Direct	Bethlehem Steel Co.
8	500	487	6600	25	Direct	Minnesota Steel Co.
8	500/330	730/485	2200	50	Gear	So. Cal. I. & St. Co.
8	500	292	4000	60	Direct	Calumet Steel Co.
8	600	550/370	3000	50	Gear	Tata I. & St. Co.
8	600	469/281	2200	25	Direct	Donner Steel Co.
8	700	364	2200	25	Direct	Laclede Steel Co.
8	800	367	2200	25	Direct	Donner Steel Co.
9	300	500	2080	25	Gear	Halcomb Steel Co.
9	300/150	590/292	2200	60	Gear	Cleveland Hdw. Co.
9	300	500/300	2200	25	Direct	Bethlehem Steel Co.
9	350	200/300	250	D.C.	Direct	Nat Farm Mach Ltd.
9	350	375/214	6600	25	Direct	Bethlehem Steel Co.
9	350	250/325	230	D.C.	Direct	Wayne Steel Co.
9	400	200/300	230	D.C.	Direct	Un. Alloy Steel Co.
9	400	485	440	25	Gear	Hess Steel Corp.
9	400/500	300/600	600	D.C.	Gear	Driver Harris Co.
9	450/360	875/700	2200	60	Gear	Nat. Lock Washer Co.
9	500	327/200	440	60	Direct	Un. Rolling Mills
9	500	435	440	60	Belt	Carnegie Steel Co.
9	500	250/350	600	D.C.	Direct	Mo. Rolling Mills Co.
9	600/400	375/210	2200	25	Direct	Forged Steel Wheel
9	600/200	321/107	440	25	Direct	Halcomb Steel Co.
9	600	200/300	230	D.C.	Direct	Un. Alloy Steel Co.
9	650	293	2200	60	Rope	Har. P. & P. B. Co.
9	800	900/720	2200	60	Gear	Knoxville Iron Co.
9	800	320	440	60	Belt	Carnegie Steel Co.
10	300	300/180	2200	25	Direct	Bethlehem Steel Co.
10	450/360	870/695	2200	60	Gear	Cleveland Hdw. Co.
10	350	360/240	240	D.C.	Direct	Laclede Steel Co.
10	350	220/360	230	D.C.	Gear	Chengtu E. L. & P. Co.
10	350	240/480	230	D.C.	Direct	Laclede Steel Co.
10	400	250/500	230	D.C.	Direct	Timken R. Brg. Co.
10	450	730/490	4000	25	Gear	Atlas Steel Corp.
10	475/350	240/181	440	25	Direct	K. C. Bolt & Nut Co.
10	485/360	870/695	2200	60	Gear	Old Dom. I. & N. Co.
10	500	244	2200	25	Direct	Bethlehem Steel Co.
10	500	500/375	2200	25	Direct	Donner Steel Co.
10	500	435	440	60	Belt	Carnegie Steel Co.
10	500	500	6000	50	Direct	Cia Electro Metal
10	500/400	775/485	550	40	Gear	Cohoes Roll Mill Co.
10	500/250	890/513	2200	60	Gear	Hunter Cruc. St. Co.
10	500	575/865	2200	60	Gear	Intl. Nickel Co.
10	575	300/214	6600	25	Direct	Bethlehem Steel Co.
10	650	500	6600	25	Direct	Illinois Steel Co.
10	600	485	2200	25	Direct	Laclede Steel Co.
10	600	365	6600	25	Direct	Minnesota Steel Co.
10	800	320	440	60	Belt	Carnegie Steel Co.
10	850	214/187	6600	25	Rope	Illinois Steel Co.
10	1000	300	2200	25	Gear	Halcomb Steel Co.
10	1000	295	2200	60	Direct	K. C. Bolt & Nut Co.
10	1200	292	2200	25	Rope	Laclede Steel Co.
10	1300	214/187	6600	25	Gear	Illinois Steel Co.
10	1500/1125	375/281	2200	25	Gear	Donner Steel Co.
10	2000	163/113	6600	25	Direct	Indiana Steel Co.
11	500	888/540	6600	60	Direct	Tenn. C.I.&R.R.Co.
11	550	120/300	250	D.C.	Direct	Firth Sterling St. Co.
12	300	720	440	60	Gear	The Stanley Works
12	300	187/112	2200	25	Direct	Bethlehem Steel Co.
12	350	150/100	6600	25	Direct	Bethlehem Steel Co.
12	400	600	440	60	Gear	The Stanley Works
12	450	450	2080	60	Gear	Columbia Steel Co.
12	500	320	2200	60	Gear	B. & O. R. R.
12	500	150/225	250	D.C.	Direct	Nat. Farm Mach. Co.
12	550/360	875/585	2200	60	Gear	Nor. & West. R. R.
12	600	214/93	6600	25	Direct	Bethlehem Steel Co
12	650	210	6600	25	Gear	Indiana Steel Co.
12	700	480/290	2200	25	Gear	Syracuse Cruc. St. Co.
12	800	730/365	2200	50	Gear	Columbia Steel Co.
12	800	705	2200	60	Gear	McConway-Torley Co
12	800	730/485	2200	50	Gear	S. Cal. Ir. & St. Co.
12	900	214/150	2200	25	Direct	Algoma Steel Co.
12	1000	350/150	2200	60	Direct	Central Steel Co
12	1200	150/250	230	D.C.	Direct	Timken R. Bear. Co.
12	1200	485	6400	25	Gear	Am. Steel & Wire Co.
12	1300/900	214/140	2200	25	Direct	Forg. S. Wheel Co.
12	1500	360/240	6600	25	Rope	Carnegie Steel Co.
12	2250	450/300	3000	50	Gear	Tata Ir. & St. Co.
12	2000	113	6600	25	Direct	Indiana Steel Co.
12	2500/1670	240/160	6300	50	Gear	Un. Steel Co., Ltd.
12	2500	113/91	6600	25	Direct	Indiana Steel Co.
12	3000	505/300	2200	60	Gear	Un. Alloy Steel Co.
14	300	720	440	60	Gear	Union Rolling Mill
14	400	585	4000	60	Gear	Calumet Steel Co.
14	450	585	2200	50	Gear	Columbia Steel Co.
14	650	184	6600	25	Direct	Indiana Steel Co.
14	500/250	130/65	440	25	Direct	Halcomb Steel Co.
14	700	730/490	4000	25	Gear	Atlas Steel Corp.
14	700	187	2200	25	Direct	Donner Steel Co.
14	700	735	4000	25	Gear	Atlas Steel Corp.
14	800	450	2200	60	Gear	Int. Nickel Co.
14	1000	590/450	4000	60	Gear	Calumet Steel Co.
14	1200/1000	300/250	4400	25	Direct	Buffalo Bolt Co.
14	3000	375	2200	25	Gear	Donner Steel Co.
14	3200	91	6600	25	Gear	Indiana Steel Co.
14	4500	500/300	2200	25	Gear	Inland Steel Co.
14	4500	67/110	500	D.C.	Gear	Ford Motor Co.
16	500	500	6000	50	Gear	Cia Electro Mach.
16	500	184	2200	25	Direct	Bethlehem Steel Co.
16	500	88	6600	25	Direct	Bethlehem Steel Co.
16	500	870	2200	60	Gear	McConway-Torley Co
16	550	880	2200	60	Gear	Danville Str. Tube Co.
16	600	500	440	25	Gear	Buffalo Bolt Co.
16	600	585/325	550	40	Gear	Cohoes Roll. Mill Co.
16	600	500	2200	60	Gear	Central Steel Co.
16	800	214/167	6600	25	Direct	Bethlehem Steel Co.
16	800	875/700	2200	60	Gear	K. C. Bolt & Nut Co.
16	800	100	6600	25	Direct	Bethlehem Steel Co.
16	800	410/720	230	D.C.	Gear	Timken R. Bear. Co.
16	1000	184	2200	25	Direct	Bethlehem Steel Co.
18	3200	91	6600	25	Gear	Indiana Steel Co.
18	450	450	2080	60	Gear	Columbia Steel Co.
18	500	500	2300	25	Gear	Halcomb Steel Co.
18	750	227	2200	60	Gear	Pacific Coast St. Co.
18	800	440	2200	60	Gear	Canton Sheet St. Co.
18	800	257	2200	60	Gear	Columbia Steel Co
18	800	94	2200	25	Direct	Forged St. Wh. Co.
18	1000	250	2200	60	Gear	Canton Sheet St. Co.
18	1500	94	2200	25	Direct	Algoma Steel Co.
18	1500	218/145	6600	25	Gear	Carnegie Steel Co.
18	2000	94	2200	25	Direct	Forged St. Wh. Co.
20	600	500	2200	60	Gear	Carpenter Steel Co.
20	600	485	440	25	Gear	Hess Steel Corp.
20	600	390	440	60	Gear	Stanley Steel Works
20	800	892/623	2200	60	Gear	Hoosier Rolling Mill
20	1000	450	2200	60	Gear	Inter. Nickel Co.
20	1000	518/800	250	D.C.	Gear	Nat. Farm Mach Ltd.
20	1100	294/205	2200	60	Rope	Un. Alloy Steel Corp.
20	1200	368	2200	50	Gear	S. Cal. Iron&Steel Co.
20	1200	590/407	2200	60	Gear	Hoosier Roll. Mill Co.
20	4000	147	6600	25	Gear	Illinois Steel Co.
21	1400/945	600/405	2200	60	Gear	Union Rolling Mills
22	800	163	2200	25	Rope	Ontario Ir. & St. Co.
22	800	730/365	2200	50	Gear	Columbia Steel Co.
22	1800	250/125	6600	25	Gear	Bethlehem Steel Co.

Mill Type Coupling Design

By GUSTAV FAST*

THIS special adaptation of Fast's Coupling, manufactured by Bartlett, Hayward Company, Baltimore, Md., to auxiliary steel mill drives, marks a definite advance in design, resulting in quick and easy application.

Figure 1 shows the two drop forged hubs of the new Fast Mill Type Coupling, ready to be connected up. The design makes it possible to quickly change the motors on table rolls, conveyor drives, skew tables, door machines on heating furnaces and other auxiliary drives in mills. When the two separated units shown in Figure 1 are moved together (the motor moved up to the drive), the insertion and tightening of a few U. S. standard bolts completes the installation.

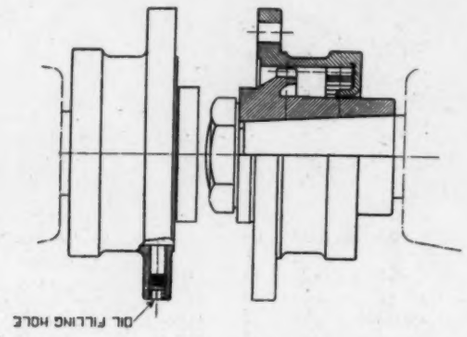

FIG. 1.

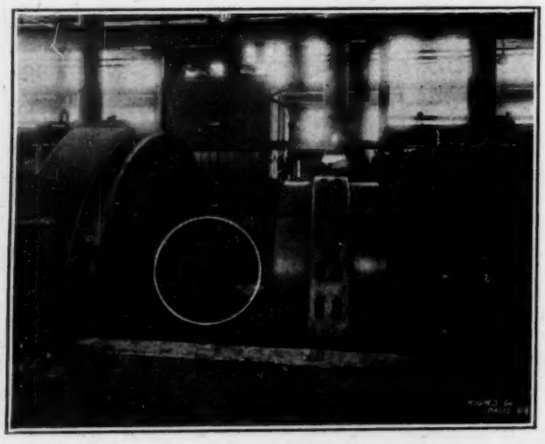

FIG. 1A.

One hub of the coupling is made to fit the full length taper of the tapered shaft of an enclosed mill type motor. The mill motor shaft carries its own lock nut, so that the hub can quickly be removed. The center flange bolts are neither shrouded nor counter sunk, as in the standard Fast designs, but are in the open, easily reached by an ordinary wrench. For the large main mill drives (see Fig. 1A), the Fast Couplings are made in cast steel with the center flange bolts unshrouded, so that the use of ordinary wrenches will disassemble the coupling.

When Mr. Gustav Fast originally designed the Fast Coupling, he blazed a new trail in coupling design. As shown in Figures 2 and 3 the standard Fast design contains no flexible materials. Two generated spur gears, one on each shaft end, are continually and completely meshed with the generated

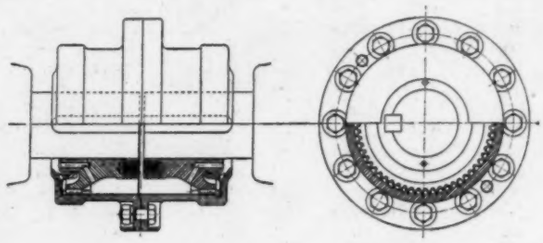

FIG. 2. FIG. 3.

internal gears of a floating sleeve. Both offset an angular misalignment as well as lateral float are easily compensated for. The industry has been so accustomed to coupling practice, involving flexible materials, such as rubber, leather, fibre, laminated steel pins, grids or discs, that the unique Fast design is often not understood. The exaggerated diagram (Figure 4) shows the simple Fast principle.

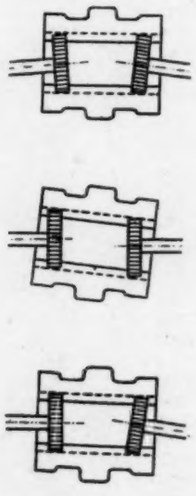

FIG. 4.

This principle of allowing errors in alignment to be taken up between the spaces of gear teeth is coupled with the principle of oiling under centrifugal pressure. The entire case of the Fast Coupling is enclosed, and partially filled with oil. When running, the oil under high centrifugal pressure is forced between the teeth, and an oil film becomes the load transmitting surface, as in a well designed bearing.

*Chief Engr., Bartlett Hayward Co., Baltimore Md.

Engineers conversant with the mathematics of design will be interested in the following:

When misaligned, the error between the gear faces is only a small fraction of the corresponding error of alignment between the shafts.

Figure No. 5 shows two shafts that are parallel but out of line an amount E. The distance between the center of gear faces is L and the width of the gear faces is f.

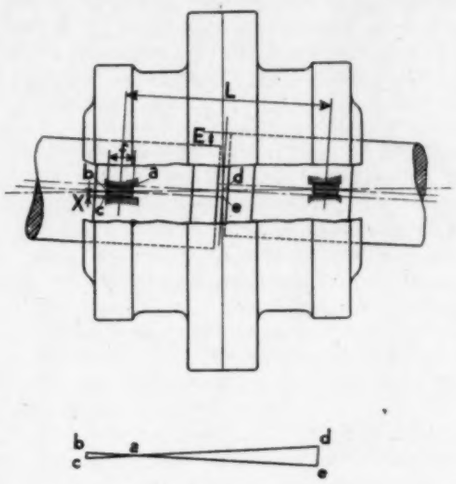

FIG. 5.

Triangles a, b, c and a, d, e are similar, therefore,

$$bc:de = ab:ae, \text{ and } bc = \frac{de \times ab}{ae}$$

Call the resulting misalignment in gear face X, which is equal to 2 bc

$$\text{now } de = \tfrac{1}{2} E$$
$$ab = \tfrac{1}{2} f$$
$$ae = \tfrac{1}{2} L$$
$$bc = \tfrac{1}{2} X$$
$$\text{then } X = \frac{E \times f}{L}$$

The ratio f/L is usually made = 1/10
Therefore X = 1/10

In other words, the error of alignment between the gear faces has been reduced to one-tenth the error in shaft alignment.

Figure 6 shows a development of an exaggerated misalignment of the gear teeth. The function of the lubricant is easily seen. When the coupling revolves, the oil is spread over the inner circumference of the casing, and the gear teeth are entirely submerged in an oil bath under pressure due to centrifugal force. Theoretically there is a load carrying contact at only two teeth, at $\frac{\pi}{2}$ and $\frac{3\pi}{2}$ 180° apart. Practically, however, there is almost uniform distribution of pressure over the entire set of gear teeth, due to the oil film.

Even under severe misalignment, the maximum opening between the gear teeth, which occurs at $\frac{\pi}{2}$ and $\frac{3\pi}{2}$ is only a few thousandths of an inch, and at π and 2π it is exactly one-half of this. On calculating the exact errors of openings between the teeth at any position, it is demonstrated that the areas of the openings is constant for all positions, and therefore the average error is a constant.

What happens to the oil?

Laboratory experiments, with pressure up to 6,000 pounds per square inch, have demonstrated that it is impossible to squeeze out the oil film between two surfaces. However, the thickness of the residual oil film is a function of the viscosity and the pressure.

In Fast's coupling, the oil, which, under centrifugal pressure is ever present in the openings or crevices between all the teeth, distributes the load

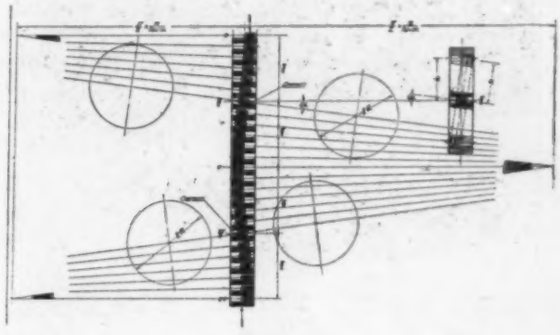

FIG. 6.

pressure almost uniformly between each engaging pair of teeth. Furthermore, noting Figure 6, the almost imperceptible motion of teeth on teeth is a rocking action, continually cushioned by the lubricant.

This lubricating principle having been demonstrated theoretically, experimentally and in actual practice, it is evident that the use of the proper lubricant for any coupling and service is all that is necessary to assure unlimited life of the coupling.

Electric Heat in the Iron and Steel Industry

By R. E. TALLEY*

THE steel industry is not taking full advantage of the possibilities of electric heat. It will do well to look carefully into the proven developments of the past few years.

The manufacturer of electric heating equipment naturally directs his efforts along lines of least resistance. Five to six years ago the electric furnace advocates were crying their wares to all lines of industry with equal fervor. The automotive industry, with a little more need and a little more daring, proved to be the more fertile field. This field, together with other lines, such as vitreous enameling, which have gone along in lesser magnitude, has kept the electric furnace manufacturer busy.

*Pres., Geo. J. Hagan Company, Pittsburgh, Pa.

The time is not yet ripe to step out and completely electrify the heating of the steel mills, but there are certain forms of electric heating which have been fully proven and found to be good. Full advantage should be taken of them.

When men first began to dream of electric heat for industry, their gaze was inevitably drawn to steel. Unfortunately for industry, some of these early advocates attempted large installations before dependable electric heating equipment was available to make their dreams come true. The result-

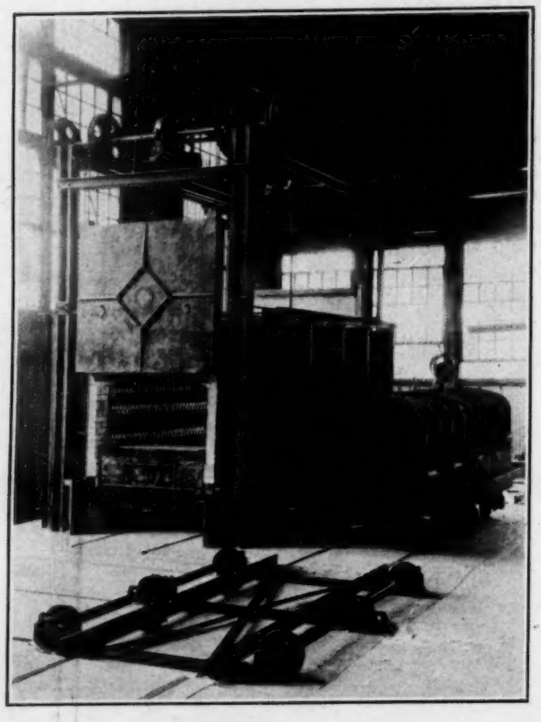

FIG. 1.

ing disasters created prejudices among steel men which it has taken years to erase. It is hard to convince the child who has had its fingers burned that one end of the poker is cold.

These unfortunate incidents can now well be forgotten. Even the type of furnaces offered by these early enthusiasts are now obsolete. In their stead there have come, by gradual process, other forms of electric furnaces which are giving results of the highest order.

Perhaps the most promising large scale application of electric heat for the steel mill lies in sheet annealing. Popular interest seems to center on white annealing. This is undoubtedly due to a considerable extent, to claims that have been made by the uninformed that electric furnaces are inherently non-oxidizing. There is still considerable to be done to make electric white annealing practical from a cost standpoint, but black annealing is worthy of immediate consideration.

There are two big items in electric heat for black annealing:

1. Quality of heat.
2. Elimination of covers.

Quality of heat is the more important. Nevertheless, it is practically impossible to obtain any allowance for it. When a steel man is found who will agree that it is worth a dollar per ton to have every pack annealed exactly the same from top to bottom and from sides to center, with no stickers and no burnt corners, then things will begin to move.

Annealing covers are not required for electric black annealing in the usually accepted sense. This statement is not set forth as being all-embracing—some forms of sheets require as careful exclusion of air for black anneal as ordinary sheets require for white anneal. Likewise, in batch type box annealers, where the hot charge is withdrawn to cool in the air, no mysterious quality can be expected of electric heat which will permit an uncovered charge of hot sheets to be withdrawn and cooled in the air.

The first commercial installation of an electric furnace for sheet annealing has now been in operation something more than four years. As a measure of safety this furnace was designed to permit the use of covers. After the first few heats the covers were permanently discarded. This furnace is of the car type and means are provided for covering the charge as soon as it is withdrawn from the furnace. Numerous other installations are now in operation and practical operating data are being gradually obtained.

The ultimate success of electric sheet annealing will undoubtedly lie in large continuous furnaces. Before this can be realized it will first be necessary to have actual operating data from smaller units to conclusively prove overall operating costs. Ample data are already available to proceed with the design and construction of the furnaces themselves. These data are based on actual operation extending over a period of years. It is now possible to pre-

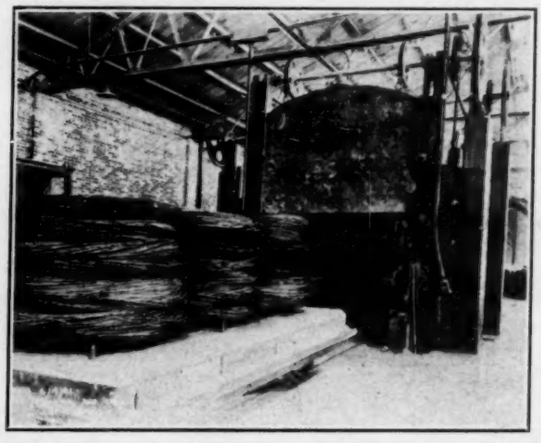

FIG. 2.

determine electric furnace characteristics with a great deal more accuracy than is possible with combustion furnaces. The points remaining to be determined have to do entirely with methods of operation and resultant overall economies.

In none of the earlier installations was it possible to show a favorable heating cost for electricity in comparison to coal or oil. The sales had to be made entirely on the basis of quality. It was very gratifying to find from these installations that not only were expectations as to quality fully realized, but the actual cost of operation was lower than with previous methods.

The regenerative car type wire annealing furnace illustrated was one of these early installations sold entirely on quality of heat. The wire was previously annealed in coal-fired and producer gas furnaces, and the quality of anneal obtained was not wholly satisfactory for the severe cold working operations to which the wire was later subjected. The electric furnace from the start gave quality and production in excess of guarantees. After a few months' operation a check-up on heating costs showed that electric heat was costing less than either coal or producer gas. After three years' operation, with still no appreciable maintenance charges against the electric furnace, the overall heating costs were one-half as much as by previous methods. The furnace has now been in continuous operation for six years, and the maintenance for the entire period is less than one per cent. While this furnace has made a splendid record, it is not exceptional; many later installations are doing equally as well.

The rotary furnaces illustrated, which are quite large as electric furnaces go, were sold with an assured production of 2,000 tons per month. They have been in operation two years and are regularly turning out more than 3,000 tons per month. In this case, the cost of electric energy is the same as the fuel cost of previous equipment. The saving in labor in favor of the electric heat amounts to $2.56 per ton. The quality of product is a real economic item, but not readily translated to dollars and cents. These furnaces have been in operation only two years and the true overall economy is, therefore, not available. Thus far the saving seems to be an annual return of 80% on the investment, without giving credit to quality, improvement in working conditions and saving in floor space.

It has quite naturally occurred to the reader that savings in labor can be made with combustion furnaces as well as electric. To some extent this is

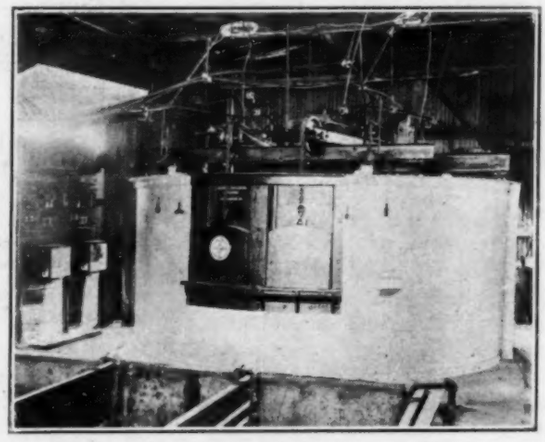

FIG. 3.

true, but there are a number of inherent factors favoring the electric furnace in this respect. In the electric furnace all combustion problems are removed bodily to the generating station, together with dust, smoke and noise. The walls of the electric furnaces can be much more heavily insulated than is permissible with combustion equipment. The resultant improvement in working conditions gives greatly improved labor efficiency; as high as 48% during summer months. The fundamental principles involved in the design of electric furnace equipment also permit of mechanical aids which are not possible with combustion equipment This difference is more clearly apparent when it is considered that an automatic electric furnace is essentially a machine with heating elements added, whereas an automatic combustion furnace must be a heat generating unit with mechanical appliances added.

There is a practical way open for the steel mills to get at this problem. In practically all mills there is a heat-treating department for shop tools, dies and miscellaneous parts. Most mills also have numerous small furnaces which are used in the production of specialties. For work of this nature electric furnaces will, in general, show a saving in operating costs and at the same time give the mill engineers personal contact with results.

A number of mills have already made the start and it has been a revelation to many of the operating men to find that electric furnaces will stand up under steel mill service. Applications of this nature can generally be made to replace antiquated shop maintenance furnaces, so that the saving in operating costs will be anywhere from 50 to 90%. Equipment installed for study can, therefore, be made to pay a profit.

There are in operation in this country at the present time, more than five hundred electric furnaces of a size large enough to be classed as industrial installations. This statement is in reference to furnaces operating at heat-treating and annealing temperature, and does not include laboratory and small tool room furnaces. Installations are increasing at a rate in excess of 30,000 K.W. per annum and the curve bends upward.

IRON and STEEL EXPOSITION

Hotel Sherman Chicago, Ill.

June 7th, 8th, 9th and 10th, 1926

FUEL
ELECTRICITY
SAFETY
MACHINERY

Apparatus Used in the Iron and Steel Industry Will Be On Display.

Application of Anti-Friction Bearings to Steel Mill Machinery

By GEORGE R. HOLMES*

OVER twenty years of intensive research and development, coupled with experience in numerous industries, in many and varied fields, has demonstrated the worth of anti-friction bearings—ball and roller—and particularly so during recent years in their application to electrical and other equipment in the steel mills of foreign countries, and even more so in the United States, where our first industry produces nearly half of the world's total of steel.

The vital need of processes and equipment which will insure the highest efficiency and uninterrupted production if low cost operation and profits are to be maintained, is one of the chief reasons why anti-friction bearings—ball and roller—have found such wide favor in the steel industry.

The innumerable machines used in carrying through from ingot to finished material—crushers, blast furnaces, blowers, compressors, mixers, cupolas, ingot buggies, roughing tables, blooming mills, hoists, cranes, etc., dwarf in size the equipment

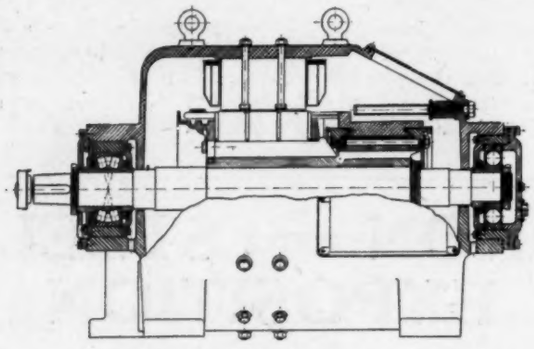

FIG. 1.

used in other industries. Each step in steel making is dependent upon the preceding one, so that a breakdown of any of these giant machines ties up production, causing expensive delays and huge monetary losses.

Keeping these machines in operation twenty-four hours a day, if necessary, without interruption, has been the problem to which anti-friction bearings have made an important contribution during recent years and even more in the past year through wide adoption for the steel mill motor—the heart of the present-day steel mill. The fact that the total consumed electrical horsepower of the steel mills of this country is nearly twice that of the next largest industry indicates very plainly what an important factor electrical equipment has become.

Extensive research work is now being conducted in our Research Laboratories and in the field on the application of anti-friction bearings to rolls. From present indications, they will be successfully applied within the near future and secure the advantages of such bearings to this important location.

Operating in a steamy or gassy atmosphere, with metal and carbon dust, around furnaces or on cranes which handle ladles of molten metal, exposed to comparatively high temperatures—all these factors are conducive to short life of motor bearings. The weakest point in the steel mill motor of today is in the bearings. This fact is well borne out by the demand of steel mills that bearings be capable of being changed as quickly as possible, so as to secure a minimum of loss in operations.

In the case of alternating current motors, over one-half or 53 per cent of all failures are directly attributable to bearings, either breakdown through mechanical failure or due to oil leakage from plain bearings. In the case of direct current motors, the percentage of failures is even more startling—62 per cent! With properly designed anti-friction bearings, it is possible to reduce, by a considerable percentage the motor failures in the steel mill.

This fact is strikingly brought out in the report of a large steel mill which replaced plain bearing motors with those having ball bearings. In many instances, plain-bearing motors, in perfect condition, were replaced with ball-bearing motors at a cost of from $600 to $1,000 and money was saved, due to the entire absence of shut-downs.

In the desire to prevent bearing failure an oiler may frequently flood the bearings and pour in with the oil a certain amount of abrasive material, on which may be placed the blame for the greatest percentage of failures on both direct and alternating current motors operating steel mill machinery. Lubricant reaches the commutators and windings, causing mica to deteriorate, shorts between the bars or between the bars and end heads and in the windings.

With ball and roller bearings there is no possibility of this lubricant leakage. Ample oil seal chambers effectively prevent the escape of oil. Motors equipped with anti-friction bearings, therefore, need fresh oil or grease but three or four times a year, and effective housing seals keep out abrasive.

Friction is reduced to a minimum when ball and roller bearings are used on electric motors to drive steel mill machinery. This results in the practical elimination of wear and attendant troubles. Their tough, hard surfaces, accurately made to within ten-thousandth parts of an inch, allow true rolling motion of the balls or rollers. There is no shaft wear with anti-friction bearing-equipped motors.

Anti-friction bearings make it possible to keep the rotor in its original position. There is no pos-

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sibility of the rotor dropping on the pole pieces, causing burnouts. The original gaps are accurately maintained and proper commutation is assured.

An important factor in the proper life of bearings, whether of the plain or anti-friction type, is that they are accurately in line. On account of the construction of steel mill motors, it is difficult to bore the bearing seats so that accurate alignment is assured. This misalignment is evidenced by excessive wear on the ends of the plain bearings and result in early failures. The limiting dimensions of a motor bearing make it almost impossible to care for these inaccuracies of machining by any pivot or cradle devices in the frame or bearing housing—the properties of alignment must be within the bearing itself to insure satisfactory service. The self-aligning bearings with their inherent property of self-alignment are, therefore, particularly adapted to the requirements of steel mill motors.

Keeping the motors which drive numerous machines in steel mills in tip-top condition, and on which the flow of work is largely dependent is, in any mill, a problem of no mean proportions. In fact, most mills have an elaborate schedule which covers all types of inspections—daily, weekly, fortnightly, etc. And all this inspection and the attendant force necessary are highly essential when machines depend on motive power from plain-bearing motors.

Failures come in spite of this vigilance, a fact which is well recognized when manufacturers of plain-bearing motors stress the need of carrying a full line of spare parts and motors for emergencies. Vibration of the gears on these huge machines pounds down plain bearings and shortens their useful life.

In practically every steel mill a number of spare motors and parts must be kept on hand for emergency use, for the failure of a single part ties up production. Frequently, complete motors are held as spares at important drives, ready to be dropped into place when the plain bearings fail. Because of their ruggedness, ability to withstand heavy shock loads, and absolute reliability, with ball or roller bearing-equipped motors, the number of spare parts may be greatly reduced.

Little attention need be given the motors so equipped, since there is no wear nor necessity for constant lubrication. This enables one man to take care of a large number of motors, both as far as their maintenance and their repair are concerned.

In fact, self-aligning roller bearings were installed on the traveler motor of an open hearth loading crane and subjected to severe reversal conditions, together with heat and dirt. This motor has been in continuous operation for more than two years, and in that time two plain-bearing motors, which are used for the same purpose, have failed nine times in one case and ten in the other because of bearing failure. The motor equipped with self-aligning roller bearings is lubricated every three months and only a teaspoonful of lubricant used. It was felt by the management that this application is the most severe to which roller bearings could be applied in a steel mill.

In another instance, the electrical superintendent of one steel mill, having 3,000 motors in operation, found that it was necessary to change bearings on an average of 100 motors per month, at a cost of $20 per motor per month. Ball-bearing vertical gas-valve motors used in the same mill have been in service over ten years and the bearings have never been changed.

In another mill it was necessary to change the plain bearings on motors driving shears once a month. A changeover to ball bearings eliminated this trouble and constant maintenance.

What ball bearings can contribute to the efficient operation of exhausters and blowers is amply borne out by the experience of one plant which so equipped a huge duplex fan. Power consumption was reduced 14 per cent, lubricating costs reduced 91 per cent, belt slippage eliminated, permitting use of a smaller pulley, total savings repaid cost of ball bearings in less than two months. The installation pays a return of 660 per cent annually on the investment.

These facts and actual figures of savings were secured for us through a survey made by an independent firm of engineers and O.K.'d by an executive of the plant in which the survey was made.

The superintendent of a large power plant states that the absolute reliability of ball bearings is one of their greatest advantages. Thirty-two motors, ranging in size from 5 to 300 H.P., are equipped with ball bearings in his plant for operating pumps and stoker drives. They have eliminated 85 per cent of all motor repairs caused by plain bearings. Coal dust, cinders, dirt and water cannot get into the bearings, as sealed housings effectively preclude the entrance of foreign matter and keep the lubricant in Bearing failures have been eliminaetd—a factor of utmost importance on this type of application.

The superintendent of a large light and power company states: "It has been found that self-aligning ball bearings for the motors offer certain very desirable advantages. Although every precaution is taken to line up the units, there is a possibility of slight misalignment, due to warpage of castings or to inaccurate machining. On the reassembling of motors after service inspection, it is possible to bolt up the end bells in a slightly cocked position. Again, the mechanic may ridge the break between the motor frame and end bell, which produces the same condition. With certain types of drives a deflection of the shaft takes place, as is evidenced by wear at the ends of plain bearings.

"With self-aligning ball bearings these possibilities of bearing failure are avoided, since this type of bearing automatically compensates for any condition of misalignment.

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Association of Iron and Steel Electrical Engineers

March 10th, 1926

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Wade, Arthur A., Vice Pres., Paul W. Koch & Co., 19 S. Wells St., Chicago, Ill.

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Walter, A. D., Secy. & Treas., The Ohio Electric & Controller Co., 5900 Maurice Ave., Cleveland, Ohio.

Walters, V. E., Salesman, Allis Chalmers Mfg. Co., 1811 Guarantee Title Bldg., Cleveland, Ohio.

Waltz, A. B., North American Mfg. Co., Cleveland, Ohio.

Walworth, Stanley L., Salesman, Pittsburgh Transformer Co., N. S., Pittsburgh, Pa.
Ward, Geo. B., Salesman, Rumsey Electric Co., 1304 Erie Ave., Philadelphia, Pa.
Watson, R. O., Mgr. Steel Mill Sec., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
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Whetstone, R. A., Mgr., Electric Storage Battery Co., Union Trust Bldg., Pittsburgh, Pa.
Whitcomb, Arthur J., Asst. Editor, Industrial Engr., McGraw Hill Co., Inc., 7 So. Dearborn St., Chicago, Ill.
White, Kenneth G., Adv. & Sales Mgr., Stroh Steel Hardening Process Co., 804 Westinghouse Bldg., Pittsburgh, Pa.
White, Francis J., Elec. Engr., Okonite Co., 501 Fifth Ave., New York, N. Y.
Whitewell, C. H., Engrg. Dept., Equitable Gas. Co., Pittsburgh, Pa.
Widdows, R. G., Sales Mgr., Electric Controller & Mfg. Co., 2700 East Seventy-ninth St., Cleveland, Ohio.
Wiley, Brent, Coml. Engr., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Williams, C. H., General Electric Co., Witherspoon Bldg., Philadelphia, Pa.
Williams, W. H., Vice Pres. & Sales Mgr., The Clark Controller Co., 1146 East 152nd St., Cleveland, Ohio.
Williford, E. A., Sales Mgr., Carbon Sales Division, P. O. Box 400, National Carbon Co., Cleveland, Ohio.
Wilson, E. H., Sales Engr., Motor & Control & Accessories, Robbins Electric Co., Liberty Ave., Pittsburgh, Pa.
Wilson, G. P., Switchboard Engr., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Wilson L. C., Republic Flow Meters Co., 412 E. Main St., Morris, Ill.
Winne, Harry A., Ind. Engrg. Dept., General Electric Co., Schenectady, N. Y.
Wohlgemuth, M. J., Switchboard Engr., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Wood, J. E., Mfgrs. Agent, Roller Smith Co., Cleveland, Ohio.
Wray, William, Mgr. Pgh. Office, Allis Chalmers Mfg. Co., 1209 Park Bldg., Pittsburgh, Pa.
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Wright, D. Clarence, Engr., Electric Controller & Mfg. Co., Cleveland, Ohio.
Wright, Robert F., Salesman, Westinghouse Elec. & Mfg. Co., Birmingham, Ala.

Y

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Youmans, W. R., Field Engr., The Ironton Engine Co., Ironton, Ohio.
Young, Warren H., Salesman, Economy Fuse & Mfg. Co., 1572 Hanna Bldg., Cleveland, Ohio.
Young, F. C., Ind. Repr., Westinghouse Tract. Brake Co., 207 Westinghouse Bldg., Pittsburgh, Pa.

Z

Zachau, Eric, Works Mgr., Shaw Crane Works, Manning, Maxwell & Moore, Inc., Muskegon, Mich.

Items of Interest

Bulletin number 151, published by the University of Illinois, covers the study of Skip Hoisting at Illinois Coal Mines, by Arthur J. Hoskin. The contents are as follows: "Advantages and Disadvantages of Skip Hoisting;" "The Skip Hoisting Mines of the State;" "Skip Hoisting Mine Bottoms;" "Skip Hoisting Plants;" "General Considerations;" "Coal Preparation;" "Degredation of Coal;" "Cost Features." Summary.

Harnischfeger Sales Corporation, distributor for Harnischfeger Corporation, announces the location of a branch office at Indianapolis, Ind., 808 Guaranty Building, Phone Circle 1719. Mr. J. H. Enochs is District Manager, in charge of this office.

A series of six articles, covering the Oil Electric Locomotive, has been issued by the Ingersoll-Rand, American Locomotive and the General Electric Companies. No. 1 article covers "The New Source of Power;" No. 2 article covers the "Best Form of Drive;" No. 3 article covers "A Saving in Fuel and Maintenance;" No. 4 article covers "A Saving in Time and Labor;" No. 5 article covers "Further Features of Advantage;" No. 6 article, "The Return on Capital Investment." Any of these articles may be secured by writing the Railway Department, General Electric Company, Schenectady, New York.

The Trumbull Electric Mfg. Co., of Plainville, Conn., has just engaged Mr. H. S. Hill, as sales representative in Atlanta. Mr. Hill will work the southeastern territory in connection with Mr. Knoeppel, who has been there for several years, and is located in Jacksonville. Mr. Hill is a graduate of the University of North Carolina, was in the Navy during the war, and is a man with engineering training.

The Graybar Tag, formerly Western Electric Dealer, is a new house magazine, which contains many interesting features in connection with electrical appliances for the home, office and factory. The editorial scope of this magazine will be very broad. For electrical dealers, a complete window display service will be run For central stations there will be many articles of information and value. Radio stations will also receive considerable notice. A story each month on railroads will also form an interesting feature of this magazine. For a copy of this new periodical, write Kenneth B. Hopkins, Adv. Dept., Graybar Electric Company, 100 E. Forty-second Street, New York, N. Y.

The General Electric Company's new industrial control catalogue is a very complete story of what this company builds and distributes in the way of industrial control. This catalogue contains 160 pages of very useful information.

The Strom Division of the Marlin-Rockwell Corp., has moved its Philadelphia office to 1211 Franklin Trust Bldg., Fifteenth and Chestnut streets. Mr. A. W. Wiese will continue as manager in that territory.

Bulletin number 2050 discusses the importance of low exciting current and its value in the operation of transformers and shows how this important feature is embodied in Pittsburgh Polyphase Transformers. It also points out other ways of saving through the use of Pittsburgh Polyphase Transformers and will, we believe, be of extreme interest to the user of transformers. Copies of this may be had by writing Pittsburgh Transformer Company, N. S., Pittsburgh, Pa.

The last issue of the Valve World, distributed by Crane Company, has many articles of interest, one in particular, "Accuracy in High Temperature Testing of Materials," by L. W. Spring, and J. Kanter. Another article, by Fred W. Venton, covering the subject of "Engine Failures due to Improper Piping," is very interesting.

The Cleveland Worm & Gear Company recently issued a bulletin, number 105, which tells a very complete story of the gears manufactured by this company.

The December 15 issue of the Delta Star Monthly issued by the Delta Star Electric Company, Chicago, contains a very interesting description of a standard outdoor construction for voltages up to and including 132-Kv. Copies will be sent upon request.

The Condit Electrical Manufacturing Corp., of Boston, Mass., has issued publication 1006-2, which describes the switch boards built by this company. This publication contains 16 pages of useful information outlining how the Condit Switch Boards are built, the material and workmanship that go into their construction, the attention that is given to special details of importance to individual installations.

"Automatic Switching Equipment," is the title of a 23-page bulletin just issued by the General Electric Company and bearing the number GEA-295. The bulletin is well illustrated and describes the application of this equipment to railway service- hydro-electric generators, mining and industrial service, central station service, etc.

Quite frequently it is necessary to protect electrical apparatus against moisture, acid fumes, etc. To meet the requirements for this work, The Cutler-Hammer Mfg. Co., Milwaukee, Wisconsin, have brought out the control station.

The mechanism is enclosed in a cast iron case, and has a cover fitted with a gasket, which excludes all moisture and fumes. A stuffing gland fitted to the shaft provides a tight joint, and the thick wall of the cast iron body allows enough threads for a tight conduit or pipe connection.

Contact is made on the brass cylinder by two heavy fingers of standard non-stubbing design. These fingers are mounted on asbestos lumber and are zinc plated as are all other small parts. The contact tips are of heavy bar rolled copper. The fingers are of sufficient capacity to permit the use of this master control station on any pilot circuit at all commercial voltages.

The large polished brass handle gives a convenient grip to the average operator. It extends far enough from the case to indicate whether the station is open or closed. All parts are generously proportioned to reduce chances of breakage in rough or careless handling. The case is sprayed with a protecting paint to withstand submersion in water or the effect of acid fumes.

This station was first installed in a rubber factory, where chemical fumes attacked the ordinary station and control mechanism, necessitating frequent repairs. Since this new type station has been installed this difficulty has been overcome entirely.

A new Bulletin, number 200, covering Roller-Smith Bond Testers and Accessories has just been issued by the Roller-Smith Company, 233 Broadway, New York, N. Y.

The Type SBT Bond Tester is not a new one and has been on the market for many years.

The Type BBT Bond Tester and the Type B Contact Bar are new devices just placed on the market. The particular application of the new BBT Bond Tester is for those applications where the current in the rail is completely feeble or where such current is absent as on new construction or at the ends of trolley lines where no cars are running beyond the point where tests are being made. The Type BBT Bond Tester has over five times the sensitivity of the most sensitive bond tester heretofore made. It can be successfully used with the current from a single number 6 dry cell The special contact bar carries a bracket for this dry cell and the necessary battery switch and contacts.

C. C. Smith, or rather "Pat" Smith, as he is better known, made fame and Walter Camp's All American as a plunging fullback on Yost's University of Michigan football team of 1917.

He did equally well as a backfield star on the great Naval Training School team at the Great Lakes.

After the close of the war, "Pat" spent several years in Russia, working with the American Relief Expedition.

Returning to America, "Pat" recognized the possibilities of the electrical industry and choose to enter it.

He is now a member of the Square D Company's sales organization and is located at 613 Bessemer Building, Pittsburgh, Pa.

A convenient chart for the use of engineers who have occasion to calculate quantities connected with the expansion of steam is being distributed by the

De Laval Steam Turbine Company, of Trenton, N. J. The well known Mollier diagram is printed upon a stiff sheet of Bristol board, attached to which is a scale, which can be broken off and used directly for measuring heat available, spouting velocity, pounds of steam per horsepower hour and duty between given pressure limits on the entropy diagram, that is, the chart and scale give these quantities directly for a perfect heat motor. If the steam consumption of an actual engine or turbine is known, the efficiency ratio is found by a simple division. The quality of the steam at the end of a perfect expansion or at the end of actual expansion of known efficiency or steam consumption is also read off immediately from the chart. Copies will be sent upon request.

The last of the six huge variable-voltage transformers designed and manufactured for the Philadelphia Electric Company was delivered recently by the Westinghouse Electric and Manufacturing Company. There were six single-phase 20,000-KVA. oil immersed, 60-cycle transformers in all, to constitute two banks delivering 60,000 KVA of electrical energy to lines supplying power to the Public Service Corporation of Trenton, and the United Gas Improvement Company of Bristol, N. J.

The transformers supplied will operate Delta connected on the low-voltage side at 13,800 volts, delivering power on Star connection at from 69,000 to 76,000 volts. The variable delivery is made possible by four steps embodied in a tap changing device designed for changing voltage under full load without shutting off the power or interfering with the transmission system or circuit-breakers

The two sets constitute the largest transformer installations ever placed in operation which include tap changing under load conditions. The specially designed tap changing mechanism is mounted in a large enclosed steel housing at the top of the transformer tanks. They are off the ground and are entered through a door which would remain locked at all times to prevent the tap settings being molested by other than those in charge.

The transformer tanks are more than 15 feet in height, with an overall clearance, including platform and bushings, of 24 feet. The tanks measure 9 feet 5 inches in diameter.

The two transformer banks are being installed in the Richmond Station of the Philadelphia Electric Company as part of the first two units of what will ultimately be eight 50,000-KVA generating and transmission units.

The Chicago Fuse Mfg. Co. has announced the appointment of F. L. Williamson as Eastern sales manager, with headquarters at 71 Murray street, New York City. He will have supervision of sales in the New York and Philadelphia territories, covering the New England States, Eastern New York, New Jersey, Eastern Pennsylvania, Delaware, Maryland, District of Columbia and Virginia.

Mr. Williamson has been identified with the electrical industry in the East for many years. Previous to joining the sales organization of the Chicago Fuse Mfg. Co., he was sales manager of the Taplet Mfg. Co., Philadelphia, for a year and a half, and prior to that time was manager of the New York office of the Economy Fuse & Mfg. Co for eight years.

During the year 1925, the Monitor Controller Company, Baltimore, Maryland, extended the field of application of its Edgewound Resistor to railway service, designed a thermal relay with all metal expansion units for its Thermaload Starter, and put on the market a new type of limit switch and also a new type of hoist controller.

Edgewound Railway Resistor

The resistor units, themselves a recent Monitor development, are of allow ribbon wound on edge in helical form and mounted on a steel-reinforced porcelain support. This method of construction relieves the ribbon of all mechanical strain, provides thorough ventilation and gives a unit that is rigid even at a red heat.

Two simple forms of clamps provide facilities for connecting adjacent units together and for taking off taps. Taps may be placed at any desired point along the resistor and changed at will, thus enabling accurate adjustment of the resistance steps to be obtained.

Individual units are mounted in banks occupying the same space as required by the common cast-iron grid railway resister, but they are much lighter in weight. As each unit is equivalent to several cast-iron grids, the number of joints is reduced to a minimum.

Thermaload Starter

Thermaload Starters are designed for all types of drive where single-phase or polyphase motors are connected across the line. They give low-voltage and overload protection, protect polyphase motors from damage due to phase failure, and permit full-load, full-torque starting.

The new type of thermal relay employed in these starters to open the main line contactor when overloads are dangerously prolonged contains no liquid of any kind. The expansion units on the relay are made of thermal metal wound in the form of a helix. One end of the helix is fixed, the other pivoted and free to turn.

The thermal, or heating elements, are located inside these helicas. When dangerous overheating occurs, the expansion units begin to untwist. Actuating arms on the free ends of the expansion units transmit this motion to the contact arm of the relay, causing the relay contacts to open. This breaks the circuit of the holding magnet of the main-line contactor, causing it to open and disconnect the motor from the line. An auxiliary contact on the relay insures flutter-proof operation

By substituting thermal elements of the proper rating, a starter may be quickly changed from one horsepower rating to another. The starter is designed for pilot-circuit operation.

Limit Switch

The new Monitor Machine Limit Switch is unusually compact in design, the overall maximum dimensions being 4x2⅛x2¼ inches. It is designed to handle the pilot circuit of either a direct or alternating current starter or controller. It may be used as

a machine limit switch; as an interlock switch, or for other purposes of like nature.

The switch is made in two types, one having normally open contacts and the other having normally closed contacts, the construction of both types being absolutely dust tight. In the stanadrd type the construction provides copper-to-copper contacts of large size which operate under heavy contact pressure. Silver contacts can be provided for special applications if desired.

Hoist Controller

The new Monitor Hoist Controller is a reversing electric controller with rope-operated-control master station, and is intended for use on traveling cranes, on chain and rope hoists, and on all other similar applications requiring a compact, substantial outfit possessing desirable safety features.

Essentially, the controller consists of two enclosed-type double-pole mechanically interlocked contactors, having graphite-to-copper contacts, blowout magnets and suitable barriers, all mounted on an 8x7-inch panel.

The control master, of the fully enclosed self-centering type is intended for rope operation, and is always in the "off" position except when forcibly held by the operator in either "forward" or "reverse" position. Bosses cast in the housing take the strain off the operating rope and protect the contacts from mechanical damage. Overall dimensions of the controller are 8½x10½x6 inches.

A thermometer similar in appearance to the usual mercury-in-glass one, but capable of registering a temperature of more than 1800 degrees Fahrenheit, has been developed in the Thomson Research Laboratory of the General Electric Company at Lynn, Mass. Instead of glass, which would melt at far lower temperatures, the thermometer bulb and steam are made of clear, fused quartz; and instead of mercury, which would boil and cause the thermometer to explode at such a temperature, gallium, one of the rarer metals, is used.

A temperature of 1000 degrees Fahrenheit is the maximum with the mercury-in-glass thermometer, and such thermometers are inaccurate at high temperatures. By the use of mercury-in-quartz, German scientists attained a previously maximum temperature of about 1300 degrees Fahrenheit.

The ordinary household thermometer has a vacuum in the stem above the mercury, and the usual high-temperature instrument uses gas under pressure in the stem. The new gallium thermometer returns to the first principle, with a vacuum or only slight amount of gas above the registering column.

The development of a method for the commercial production of clear fused quartz as tubing was the first development in the Thomson research laboratory that made the new instruments possible The other necessary study was in regard to the physical and chemical properties of the rare metal-gallium.

This metal is similar to mercury in appearance, but is much lighter in weight. It melts at a temperature of 100 degrees Fahrenheit, but can be cooled to about 40 degrees before solidifying. Gallium boils at about 3600 degrees, so that it is not necessary to have it under pressure in the thermometer.

In making the thermometers, it is necessary to have the gallium very pure, since slight traces of certain impurities so affect the metal that it sticks to or "wets" either glass or quartz. "Wetting" makes a metal unsuitable for use in thermometers. It was therefore necessary for the scientists to investigate the properties of the metal before a process could be developed whereby the pure gallium could be obtained within the stem of the thermometer.

Even further research was necessary, however, since it is not possible to etch and mark quartz in the way that glass is handled in thermometer manufacture. It was found that cold hydrofluoric acid, used for glass, attacks the entire quartz surface in spite of protective coatings. The etching was accomplished by using hot, dilute hydrofluoric acid, with polymerized chinawood oil as a protective coating. To make the etching easily visible, a composition of sand and copper oxide was used to produce grayish-black marks; this substance not only withstands the intense heat, but also resist most chemical reagents.

Such devices as thermocouples, pyrometers and similar devices have been needed previously for high temperature readings. The new thermometer permits accurate high temperature determinations in the usual manner.

Sylvester Boyer of the Thomson Research Laboratory, in describing the gallium-in-quartz, thermometers in the December issue of the Journal of Industrial and Engineering Chemistry, points out that a number of these thermometers have been used with satisfactory results in laboratory work, but that the production of the instruments has been more of a purely scientific investigation. Development in the work will be continued if interest in such an instrument seems to warrant it.

One advantage of the use of quartz for thermometers is its low coefficient of expansion. Thus quartz is not affected by sudden changes of temperature which would shatter glass.

Gallium-in-quartz thermometers are the latest of a number of instruments made possible by clear fused quartz. Other recent developments have included quartz motion picture lenses, a large variety of medical and surgical instruments, quartz paning for windows for medical studies, and improved astronomical mirrors.

Gallium was discovered in 1876 by Lecoq de Boisbaudran. During the following four or five years considerable experimental investigations were carried on by him and others, but in the following period of 40 years little work was done with the element.

In the United States a source of gallium was discovered ten years ago in the "leady residues" left after the distillation of zinc from certain ore. Residues obtained from such ores in the Missouri and Oklahoma regions contain considerable gallium but, since there were no commercial uses for the metal, these residues were not worked for their gallium content. Instead, they were sold for their lead value.

The application of gallium in a cadmium lamp for monochromatic light has been reported but seemingly has not been commercialized. At present, gallium cannot be obtained in quantities on the market, but the use of the metal for thermometers will probably make such production possible.

After many months of experimentation under the Ringsdorff formulae, the National Carbon Company has succeeded in producing the world famous Ringsdorff ET-10 brush for rotary converters and has now placed the American-made product on the domestic market.

The accomplishment, which has been verified, tested and enthusiastically endorsed by Hans Ringsdorff, is an outstanding achievement in American industrial science, inasmuch as similar experimental efforts have been made in almost every country in the world without success. Heretofore, only at the Ringsdorff plant at Mehlem, Germany, has it been possible to manufacture the ET-10 brush.

When the National Carbon Company secured the American rights to the Ringsdorff invention, it first imported the fully manufactured brush from Germany. Later the raw materials were imported and assembled here. As a result of the recent achievement, the entire manufacturing process will be carried out at the company's plant in Cleveland, which will mean an absolutely sure and continuous source of supply, carried on by American technical experts.

Commenting on the successful outcome of the experiments in this country, Mr. Ringsdorff writes the National Carbon Company as follows:

"As I told you when I was over there, the American-made ET-10 is apparently just as good as the material made by us in Mehlem. This impression has been fully confirmed by the experiments which we have made on your material which I brought back with me, and I congratulate you on being able to control this relatively difficult manufacturing problem in such a short time."

A further development in brushes for rotary converters was also announced by the National Carbon Company with its new National Grade 541 brush, an entirely American product. This is a specially impregnated brush, which will require additional lubrication after a few months' service, but where operators are willing to perform this additional lubrication, the new brush offers exceptionally long life and economical operation. Specially selected materials and new processes of manufacture developed by the National Carbon Company engineers enter into the making of the 541, which has already received the general endorsement of the electrical industry.

Worm reduction gears, as recently developed for the driving of slow and moderate speed machinery by means of standard high speed electric motors, give speed reductions from 4 to 1 to as much as 100 to 1 in one step, with satisfactory efficiency, but for higher ratios, a one step worm gear would either require an inconveniently large wheel or else the teeth would be too small and weak.

For ratios above 100 to 1, as required for driving cooling tables, conveyors, stokers, heat treating furnaces, escalators, etc., it is therefore desirable to use two steps, with which the highest reduction ratios ordinarily required are readily attained. The two stage worm reduction gear has been developed by the De Laval Steam Turbine Co., of Trenton, N. J., for ratios up to 8,000 to 1. The one casing carries all bearings for the high speed worm shaft, the low speed worm shaft, which also carries the high speed wheel and the low speed wheel shaft, thereby insuring accurate alignment and perfect meshing. There are only three working members, excluding the ball bearings of the two worm shafts, and these parts are heavy and rugged. End thrust and bending strains from the driving and driven machine are avoided by the use of flexible couplings of the pin and rubber bushing type.

The one piece casing also acts as an oil reservoir, the oil being carried at such height that it touches the high speed wheel and the low speed worm at all times. In addition a positive oil pump draws oil from the reservoir and forces it through passages to the low speed shaft bearings. This is a valuable feature, as it is practically impossible, due to the low speed of this shaft, to lubricate the bearings satisfactorily by splash. Suitable filling and drainage openings and oil cocks are provided for controlling the oil level. Escape of oil along the high speed worm shaft is prevented by a packet gland, while the seepage of oil along the low speed shaft is avoided by the use of an oil slinger working between the end of the bearing and an oil guard surrounding the shaft and held in grooves in the casing and cover.

General Electric Catalogue 6001-B, superseding all previous catalogues issued by the company, with the exception of those dealing with railway, mine and industrial supplies and merchandise products, is being distributed. The complete catalogue is issued every two years.

The book is two inches thick, and contains more than 1100 8x10½-inch pages. The illustrations total more than 3200.

The catalogue is thumb-indexed into 16 sections as follows: Generation, wire and cable, distribution transformers, arresters, voltage regulators, switchboards and accessories, meters and instruments, motors, motor applications, industrial control, railway, lighting, indutrial heating, miscellaneous, and indexes. In the indexes, products are classified both by subject and by catalogue numbers.

SAFETY CONGRESS

(Continued from Page VII)

Every Steel Plant in this country co-operated with the A.I.&S.E.E. to such an extent that in 1913 the A.I.&S.E.E. invited all the industrial plants in the United States to participate in what is known today as the First Co-operative Safety Congress.

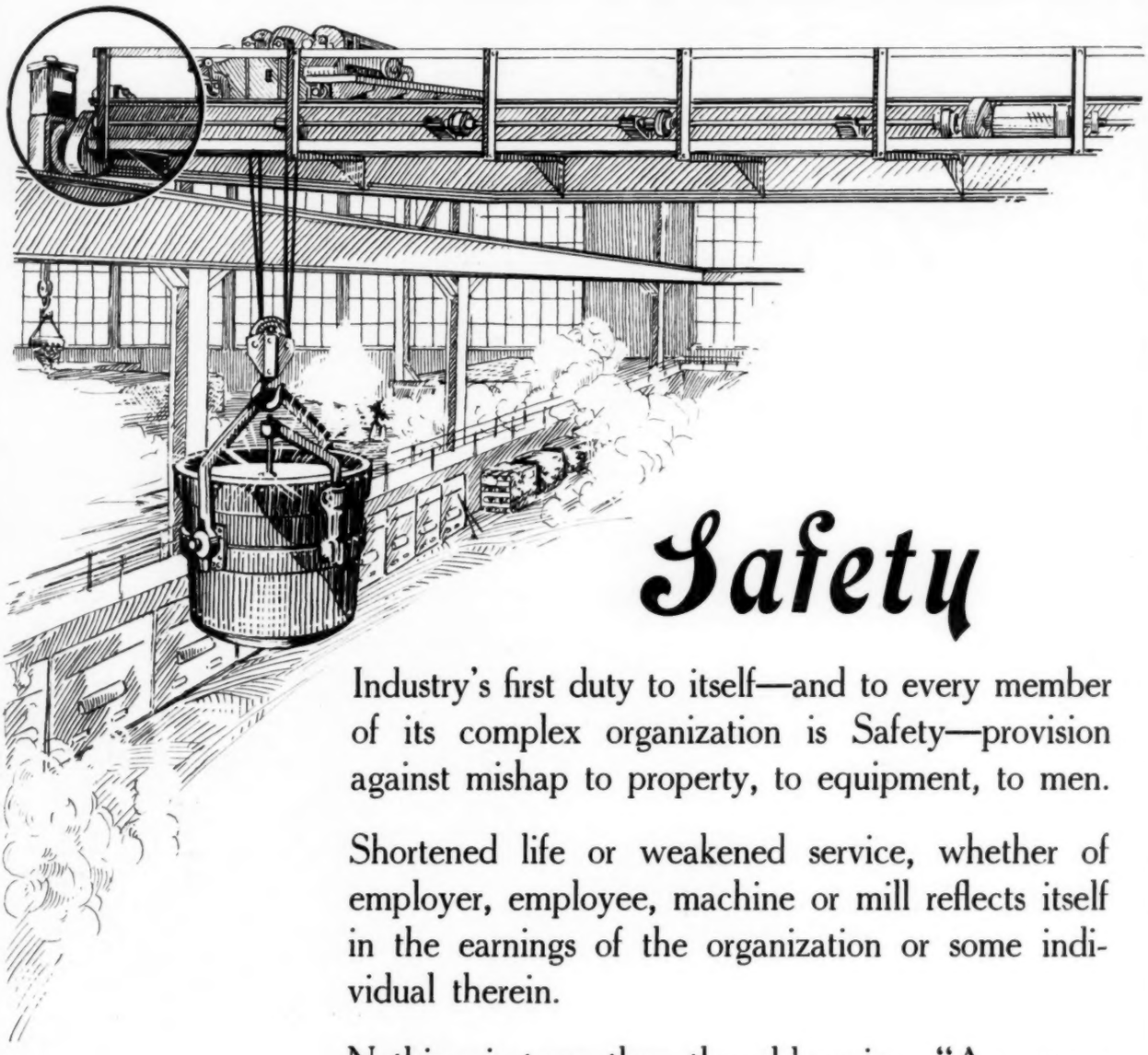
Ten thousand copies of the transactions of this Congress were printed and distributed throughout the industries in the United States.

Out of the First Co-operative Safety Congress came the National Safety Council.

Now, what will come out of the Safety Congress being conducted by the A.I.&S.E.E. March 10th, 1926, at Pittsburgh, Pa. Plant Managers, Safety Directors, Electrical Engineers and Superintendents, Crane Builders, Electrical Manufacturers, all will meet on a common ground to discuss the Safe Operation of Electric Overhead Traveling Cranes. One thing we are sure of—there will be less lost time accidents in connection with the Operation of Electric Overhead Traveling Cranes in the year 1926. True, in order to make this prediction a possibility, you must attend this Congress and contribute your share.

Will you be there?

ADVERTISING PAGES REMOVED



Safety

Industry's first duty to itself—and to every member of its complex organization is Safety—provision against mishap to property, to equipment, to men.

Shortened life or weakened service, whether of employer, employee, machine or mill reflects itself in the earnings of the organization or some individual therein.

Nothing is truer than the old saying, "An ounce of prevention is worth a pound of cure."

An expenditure for safety is a far more economical move than the hope "that nothing'll happen" which costs nothing—it is an investment in happier, more progressive, more profitable business.

N-L

The Nichols-Lintern Co. is proud of its association in the cause of Safety—proud of the products which have made the mark "N-L" almost synonomous with "Safety".